

STATE COLLEGE OF WASHINGTON
AGRICULTURAL EXPERIMENT STATION
Pullman, Washington

DIRECTOR'S OFFICE

Forty-Second Annual Report

For the Fiscal Year Ended June 30, 1932

BULLETIN NO. 275

December, 1932

All bulletins of this Station are sent free to citizens of the State
on application to the Director

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W. A. Rockie, B.S., Scientist in Soil Erosion, U. S. D. A.²

Animal Husbandry

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Jerry Sotola, M.S., Asst. Animal Husbandman.
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R. E. McCall, M.S., Assistant in Animal Husbandry.⁴

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Otto Johnson, M.S., Assistant Chemist.
Kermit Groves, Ph.D., Assistant Chemist.

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E. V. Ellington, B.S., Dairy Husbandman in Charge.
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N. S. Golding, Ph.D., Acting Associate Dairy Husbandman.⁴
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Entomology & Zoology

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James Marshall, M.S., Assistant Entomologist, Wenatchee.¹
Arthur J. Hanson, M.S., Assistant Entomologist, Western Washington Experiment Station, Puyallup.

Farm Management & Agricultural Economics

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E. F. Dummmeier, Ph.D., Agric. Economist.
Chester C. Hampson, M.A., Assistant Agricultural Economist.
E. F. Landerholm, M.S., Asst. in Farm Management.
A. A. Smick, M.A., Asst. in Rural Sociology.

Home Economics

Florence Harrison, A.M., Home Economist in Charge.
Evelyn H. Roberts, M.S., Research Specialist in Home Economics.
VeNona W. Swartz, M.S., Research Specialist in Foods and Nutrition.

Horticulture

E. L. Overholser, Ph.D., Horticulturist in Charge.
O. M. Morris, M.S., Horticulturist.
F. L. Overley, M.S., Associate in Horticulture, Wenatchee.
C. L. Vincent, M.S., Asst. Horticulturist.
J. W. C. Anderson, M.S., Asst. Horticulturist.
L. L. Claypool, B.S., Asst. Horticulturist, Irrigation Branch Station, Prosser.
Kenneth A. McKenzie, M.S., Assistant in Horticulture, Wenatchee.
C. D. Schwartz, B.S., Research Assistant.

Plant Pathology

F. D. Heald, Ph.D., Plant Pathologist in Charge.
L. K. Jones, Ph.D., Assoc. Plant Pathologist.
C. S. Holton, Ph.D., Agent, U. S. D. A.²
Grover Burnett, Ph.D., Research Assistant.

Poultry Husbandry

John S. Carver, B.S., Poultry Husbandman in Charge.
Donald Brazie, M.S., Asst. Poultry Husbandman.

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J. W. Kalkus, D.V.S., Veterinarian in Charge, Western Wash. Exp. Station, Puyallup.
C. E. Sawyer, D.V.S., Research Veterinarian, Western Wash. Exp. Station, Puyallup.

Branch Stations

H. M. Wanser, M.S., Supt. Adams Branch Station, Lind.
H. P. Singleton, M.S., Superintendent, Irrigation Branch Station, Prosser.
D. J. Crowley, B.S., Specialist in Cranberry Investigations, Cranberry Investigation Laboratory, Long Beach.

Pacific Northwest Soil Erosion Station

W. A. Rockie, B.S., Superintendent.
P. C. McGrew, B.S., Agricultural Engineer.
Arthur J. Johnson, Agent.

¹ In cooperation with the State Committee on the Relation of Electricity to Agriculture

² In cooperation with the United States Department of Agriculture.

³ On leave.

⁴ Appointment effective July 1, 1932.

⁵ Acting Extension Horticulturist, August 1, 1932.

⁶ Appointment effective August 1, 1932.

⁷ Appointment effective August 5, 1932.

⁸ Appointment effective September 16, 1932.

LETTER OF TRANSMITTAL

State College of Washington
Pullman, Washington
December 6, 1932

His Excellency, Roland H. Hartley, Governor
Olympia, Washington

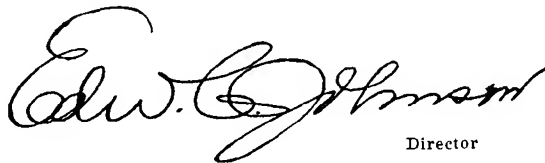
Sir:

Pursuant to federal statutes I have the honor to present herewith the annual report of the activities of the Washington Agricultural Experiment Station and branch stations, State College of Washington for the year ended June 30, 1932.

Since some results of the station work are summarized most conveniently on a basis of the crop season this practice has been followed in parts of this report. Where this is the case the content so indicates.

Statements of the receipts and expenditures for the fiscal year, as prepared by the treasurer of the experiment station, are included.

Very respectfully,

A handwritten signature in dark ink, appearing to read "E. W. Johnson". The signature is fluid and cursive, with a large initial "E" and a long, sweeping underline.

Director

FORTY-SECOND ANNUAL REPORT

Washington Agricultural Experiment Station

DIRECTOR'S STATEMENT

Introduction: In view of the critical situation in agriculture the work of each division of the experiment station during the year has been directed largely towards major agricultural problems of immediate importance. This policy has been reflected in an emphasis upon what often is called the more practical phases of agricultural research. It has been reflected also in the efforts made by the experiment station in cooperation with the extension service to put the findings of the station in such a form that they may be available to the farmers of Washington as rapidly as possible. This policy has been made effective in other directions. Only a few may be mentioned here.

Timely Economic Information: The experiment station and the extension service have undertaken to assemble and publish each month up-to-date information upon the economic situation and the outlook for agriculture, in order that this may serve as a guide to the farmers of Washington in their operations from month to month. The information assembled is based upon careful economic research by various departments of the United States government and by this experiment station and on analysis of factual material from all available sources. It is published and distributed in bulletin form and is furnished to the general press and the farm papers in news releases and special articles.

Fertilizer Recommendations: Each year, as a result of experimental work, experiences of farmers and fertilizer companies, and tests, observations and demonstrations conducted by county agents and Smith-Hughes teachers, information on soils, soil fertilization and conservation of soil resources is accumulated. In order that this might be assembled and furnished to the farmers of Washington, the experiment stations and extension service of the State College cooperated with the Washington State Chamber of Commerce in conducting two conferences to which farmers, representatives of farmers' organizations,

the State Bankers' Association, the Smith Hughes Agricultural Service, the railroads, the State Department of Agriculture, the fertilizer industry, and the agricultural press were invited. At these conferences all available information was canvassed and agreement was reached on recommendations to be made on soil fertility and the uses of fertilizers for the year 1932. These were published through the extension service, and were broadcast throughout the state through the regular publicity channels.

Feed Recommendations: Conferences were held between representatives of the experiment stations and the extension service and the Feed Dealers' Association of Washington, the Washington Cooperative Egg and Poultry Association, and others, with reference to the use of the results of experimental work on feeds in the manufacture and sale of feeds for poultry and dairy cattle. As a result, information developed in completed research and in experimental work in progress is followed in the preparation of between 50 and 75 per cent of the poultry feed and much of the dairy feed sold in Washington, with consequent savings in costs of feed to the farmer and the manufacturer.

Spray Program: Conferences between specialists in entomology and horticulture of the experiment station and extension service, the State Department of Agriculture, and the U. S. Department of Agriculture were held as in previous years to formulate the spray program for the control of the most serious pest of the apple industry, namely, the codling moth. The results of the year's experimental work by all agencies were considered and with these as a basis, spray recommendations for the horticultural industry of the state were adopted. These were published by the institution and by the farm press and served to guide the spraying practices in the fruit sections.

Pea Weevil Recommendations: Through conference and joint action of representatives of the Washington experiment station, the Idaho experiment station, and the U. S. Department of Agriculture, recommendations were developed early in the 1932 season for the reduction of weevil damage in the pea fields of eastern Washington and northern Idaho.

Livestock Recommendations: Conferences between the representatives of the institution and leaders in the livestock industry have been held to consider recommendations that should be made relative to livestock production and a balanced agriculture. The results of experimental work in livestock feeding and of research in the economics of the livestock industry have been used as a basis for recommendations made.

Research on Fundamental Problems: At the same time that this work of immediate service to agriculture has been under way, every effort

has been made to continue the program of research on some of the fundamental problems of the agricultural industry that must be maintained from year to year if worthwhile results are to be secured. The steady accumulation in this manner of facts and principles relating to the various agricultural enterprises furnishes an essential part of the background required in the formulation of sound principles for the state's agriculture.

Investigations in Cooperation with the United States Department of Agriculture

Helpful and effective cooperation from the U. S. Department of Agriculture has been available during the year in a number of the experimental and research projects of this station. The work done is described in the divisional reports already mentioned. The cooperating bureaus and offices are as follows:

Bureau of Plant Industry

- Division of Cereal Crops and Diseases
- Office of Western Irrigation Agriculture
- Office of Forage Crops

Bureau of Agricultural Economics

- Division of Farm Management and Costs
- Division of Farm Population and Rural Life Studies

Bureau of Dairy Industry

- Division of Dairy Cattle Breeding, Feeding, and Management

Bureau of Chemistry and Soils

- Pacific Northwest Soil Erosion Experiment Station

Bureau of Agricultural Engineering

- Pacific Northwest Soil Erosion Experiment Station

Investigations in Cooperation with Commercial Agencies

Research fellowships for investigation of specific problems are furnished to the experiment station by a number of cooperating agencies. The Colloidal Products Corporation of San Francisco, California, and the Crop Protection Institute with headquarters at Durham, New Hampshire, for a number of years have cooperated in studies of spray materials and orchard insect control at the Wenatchee laboratory and are continuing this work.

The National Oil Products Company, Inc., of Harrison, New Jersey, and the F. E. Booth Company, Inc., of San Francisco, California, are cooperating through research fellowships and maintenance of experimental studies in the use of vitamin-bearing oils for poultry

Other Cooperative Undertakings

Chelan county has continued its cooperation for the thirteenth consecutive year in the horticultural and spray investigations at the horticultural field laboratory at Wenatchee. In this way it has been possible to maintain the work of that laboratory without interruption.

This experiment station and the experiment stations of Idaho, Oregon, Montana, California, British Columbia, and the U. S. Department of Agriculture have continued the cooperative studies in the use of oil sprays for insect control commenced six years ago.

The Northwest Fertilizer Conference, consisting of a group of horticulturists, entomologists and plant pathologists, met for the second time and serves as a medium for the correlation of studies in orchard soil fertility and orchard fertilization. The purpose and plan of this conference was discussed in the last annual report.

County agents and Smith Hughes teachers have cooperated effectively with the Division of Agronomy of the experiment station in experimental work with crops, soils and fertilizers in the more important crop areas throughout the state.

The Wenatchee Valley Traffic Association has cooperated in the horticultural investigations conducted in the Wenatchee area for a number of years and continued its support during the current year

The Station Program

The program of the agricultural experiment station and branch stations is described briefly in the divisional reports in succeeding pages. These make clear that some of the more important problems in each one of the special fields of the state's agriculture are receiving attention. However, numerous other investigations and studies and an enlargement of the program now under way, from time to time, have been urged upon the experiment station by representatives of the various agricultural industries of the state, by other groups and by individuals both in conference and in correspondence.

Specific requests have been made by leaders in the horticultural industry for more experimental work in that field, especially with relation to orchard soil fertility, insect control, general orchard management and by-products.

The poultry industry for several years has been eager for increased experimental work with home grown feeds for poultry, the use of minerals, fish by-products and vitamin-bearing oils in poultry feeding, and housing, breeding, and disease control problems.

The dairy industry has been interested in additional studies on the value of feeds grown under various climatic and soil conditions and more especially the effect of feeds produced on low mineral content soils on the growth, reproduction and lactation of dairy cattle

The livestock group has been interested in more feeding tests with beef cattle and sheep, and in additional feeding and management work with hogs.

The matter of an inventory of the state's land resources through a soil survey and land classification to serve as the basis for a comprehensive state development program is receiving the thought of many leaders. By means of soil surveys agricultural and non-agricultural lands are classified and the soils are differentiated with reference to their adaptation to general farming, grazing, and various specialized uses. Only about 14 per cent of the total soil area of Washington has been surveyed in detail and about 18 per cent in less detail through so-called reconnoissance surveys.

Large areas of land not farmed and of little economic use have potential possibilities for grazing, reforestation and recreation. Other land now in farms is marginal or submarginal in character. Much of this land has been logged off, cut over, or burned. The only known method of arriving at a sound policy for its utilization is through classification with reference to topography, soils, present cover, location with reference to roads and markets, and production possibilities.

From time to time as research work continues and certain studies are completed some of the problems listed will be studied. On the other hand, every year brings new problems in agriculture so that as some are solved others require attention. Only by a permanent, vigorous program of agricultural research can these problems be met and solutions found.

Changes in Staff

Anthony Spuler, associate entomologist of the experiment station, and Mrs. Spuler were drowned at Lake Wenatchee, Washington, May 30, 1932, when their small motor boat capsized in a storm. Mr. Spuler received his bachelor's degree in zoology in 1917 and his master's degree in 1919 from the State College of Washington, and had been a member of the teaching and experiment station staff since his graduation. He was known not only to the horticultural industry of Washington, but throughout the nation for his effective work in orchard insect control. Many of the results obtained in his investigations are the basis of established orchard spraying practices in the Pacific Northwest. The development of the use of the moth trap as an indicator of when to spray, and the results of far reaching studies in the use of chemicals, oils and of spreaders in insect control placed him in the front rank of economic entomologists. They are an enduring monument to his capacity and his genius. His untimely death interrupted the research career of an exceptionally able scientist.

Mr. A. A. Smick was appointed Assistant in Rural Sociology July 1, 1931.

Dr. L. C. Wheeting was appointed Associate in Soils July 1, 1931.

Mr. Donald Brazie was appointed Assistant in Poultry Husbandry July 15, 1931.

Mr. Rex E. Willard was appointed Head of the Division of Farm Management and Agricultural Economics October 15, 1931.

Mr. Max B. Hardy, Research Assistant in Horticulture, resigned October 25, 1931.

Mr. C. D. Schwartze was appointed Research Assistant in Horticulture February 15, 1932.

Mr. Kenneth A. McKenzie was appointed Assistant in Horticulture April 11, 1932.

Dr. N. S. Golding was appointed Acting Associate Professor in Dairy Husbandry July 1, 1932.

Mr. Ralph McCall was appointed Assistant in Animal Husbandry July 1, 1932.

Mr. G. B. Swier was appointed Assistant in Animal Husbandry July 1, 1932.

Mr. H. A. Bendixen, Associate in Dairy Husbandry, was granted a year's leave of absence beginning July 10, 1932.

Detailed Reports

The work of each division of the Washington Agricultural Experiment Station and of each Branch Station is summarized in brief statements in the following pages of this report.

Lists of bulletins and other published papers for the year as well as financial statements are included.

DIVISION OF AGRICULTURAL ENGINEERING¹

L. J. Smith in Charge

Heat Movement in Soils. (H. L. Garver). Investigations of the movement of heat in various types of soils, with different moisture contents, and with electrical resistance wires as the source of heat are being continued. The object is to secure fundamental data on which to base recommendations concerning the depth and the spacing of the resistance wires for hot bed work, and for other soil heating.

¹ Much of the work done by this division has been in cooperation with the Committee on the Relation of Electricity to Agriculture.

Work is being done in cooperation with the Division of Horticulture both in hot beds and in the open garden.

Apple Washing. (H. L. Garver). The Washington Committee on the Relation of Electricity to Agriculture is cooperating with the Divisions of Horticulture, Entomology and Chemistry of the Agricultural Experiment Station, and with Homer J. Dana of the Engineering Experiment Station, in improvements in apple washing methods. Plans were drawn and an experimental machine constructed capable of using a variety of chemicals and washing solutions. Improvements in this machine over those in commercial use have proven practical and offer considerable promise in connection with the apple washing problem.

Evaporation Studies. (H. L. Garver and L. J. Smith). The studies of evaporation losses from sprinklers under various weather conditions and with different quantity of sprays, conducted in cooperation with the Irrigation Branch Experiment Station at Prosser, have been completed. The results will be given in the 1932 Annual Report of the Washington Committee on the Relation of Electricity to Agriculture.

Water Heating for Dairy Cows. (H. L. Garver and L. J. Smith in cooperation with the Division of Dairy Husbandry). A study to determine the value of heating water for dairy cows, has been inaugurated and will be conducted during the winter season, 1932-33.

Electricity on the Dairy Farm. (L. J. Smith). The compilation of a bulletin on electricity on the dairy farm is under way. The electrical requirements of different types of dairy farms in the state of Washington, and the application of electrical equipment to these requirements will be discussed.

Electricity on the Poultry Farm. (H. L. Garver and L. J. Smith). Studies have been continued on all-night lighting for laying hens and the Jones electric brooder. A manuscript on Electricity on the Poultry Farm has been completed and will be published.

Grain Elevating Machinery. (H. L. Garver). A two-years' study on grain elevation for farm storage and car loading has been completed. The results are given in Washington Experiment Station Bulletin 262.

Orchard Irrigation by Overhead Sprinklers. (H. L. Garver). A two-years' study of this project in cooperation with other divisions of the Experiment Station and the U. S. Department of Agriculture has been completed. The results are given in Washington Experiment Station Bulletin 268.

Progress Report of the Washington Committee on the Relation of Electricity to Agriculture. (L. J. Smith, Secretary, and H. L.

Garver, Investigator). The Seventh Annual Progress Report of the Washington Committee on the Relation of Electricity to Agriculture was released in January, 1932. This is a 70-page mimeographed report of the activities of the Committee for 1931. It includes many blue prints and charts, and deals with the influence of ultra-violet light on milk production, carbon lamp brooder tests, grain elevating, irrigation studies, apple washing, and soil heating.

DIVISION OF AGRONOMY

E. G. Schafer in Charge

Varietal and Cultural Investigations. (O. E. Barbee and O. A. Vogel, in cooperation with the Office of Cereal Crops and Diseases, U. S. Department of Agriculture.) Cereal crop investigations were carried on as in former years. All the cooperative varietal plots were continued, and an additional trial plot was started this year at Reardan in Lincoln county on the farm of Arthur Carstens.

At Pullman 425 varieties, selections, and hybrids of winter wheat were grown in triplicated rod rows 18 inches apart. The major portion of these consisted of introductions, pure line selections, and bunt-resistant hybrids.

Winter injury caused poor stands in the single rod row trials and low yields resulted. A few strains yielded more than 50 bushels per acre while others yielded less than 20 bushels.

Seventy-six varieties were grown in triplicated three row blocks. These varieties were sown with a garden drill at a rate approximately twice that of the single rows, and 11 strains produced yields of more than 50 bushels per acre.

In April, 162 varieties and hybrids of spring wheat were planted in triplicated rod rows one foot apart and 126 varieties in triplicated three row blocks. No duplications were made in these two trials except in the use of Baart and Bluestem as checks. The yields of spring wheat varied from 24 to 62 bushels per acre.

Tests were continued at Walla Walla and Pomeroy where 56 varieties of winter wheat and 43 of spring wheat were grown in triplicated three row blocks. The winter wheat at Walla Walla shattered badly on account of two severe wind storms a few days previous to harvesting.

This test gave valuable information on varieties in regard to their ability to withstand shattering, a factor that was previously determined to a limited degree only. The yields for winter wheat showed a wide range while those of spring wheat were more uniform.

At Pomeroy shattering was not as severe as at Walla Walla, but burning was noticeable for both winter and spring crops. The winter wheat yields at this point did not show as wide a range as at Walla Walla since a majority of the varieties produced about 30 bushels. The spring wheat showed more injury from hot winds than did the winter wheats. Yields secured were low and bushel weight varied from 46 to 57 pounds. The yields ranged from 15 to 23 bushels with most of them below 20.

The results from the varietal trials at St. John in Whitman county were uniform for both the winter and spring wheats. Varietal tests on a smaller scale were continued in five counties in eastern Washington.

Row trials of winter barley, spring barley, oats, and flax were conducted in a manner similar to those of wheat. The winter barleys showed a high degree of winter injury, but of the 21 varieties White Winter showed the least injury and produced the highest yield. Of the 67 varieties of spring barley grown, Beldi Giant ranked first and Trebi second. For the oats, Markton and a cross of Gray Winter and Argentine ranked first in yields of the 71 varieties grown, producing approximately 90 bushels per acre. Of the 12 wilt-resistant varieties of flax grown in triplicated row rows Bison was slightly in the lead in production this year. Seeding flax at the rate of 35 pounds per acre gave better yields than both lower and higher rates.

Sixty-two winter and spring varieties of wheat, oats, and barley were replicated four times in one-fortieth acre field plots, two following summer fallow and two following peas.

Seed Distribution. (E. G. Schafer). Ridit and Albit, which were produced at this station, were foremost among the varieties of wheat requested this year. One hundred forty-six bushels of Ridit and 170 bushels of Albit were sent to 18 farmers. Triplet, Marquis, Baart, Hybrid 128, Federation, and Hard Federation wheats were distributed in smaller amounts. One hundred seventy-six bushels of Markton, the only variety of oats distributed, were sent to 12 farmers. A total of 94 bushels of White Winter, Horsford, and Beldi Giant barleys were shipped to seven farmers. Four farmers received 247 pounds of Thayer Yellow and Windus White varieties of corn. In addition, numerous small samples were sent to experiment stations, county agents, and farmers for experimental purposes.

The work of encouraging the production and distribution of certified seed by qualified individuals was continued.

A seed house containing storage space for sack grain, fumigating room, drying room, tool room, and fireproof room for storage of numerous lots of seed for experimental use was built during the year. The house is equipped with sack elevator and platform scales. Seed

cleaning machinery will need to be provided and installed before cleaning for seed distribution can be handled most effectively.

Inheritance Studies in Cereals. (E. F. Gaines and A. M. Schlehner in cooperation with the Office of Cereal Crops and Diseases, U. S. Department of Agriculture). Nearly 2,000 varieties and hybrid selections of winter wheat were analyzed in 1932 for relative resistance to one or more physiologic forms of bunt. Infection varying from 75 to 100 per cent was obtained on susceptible varieties whereas 98 resistant wheats were smut free from all nine forms of bunt with which the seed was inoculated. The more vigorous and promising of those proving immune or highly resistant were advanced to the yield plots for further testing. New hybrids were made between the most resistant and prolific strains. Third generation progenies of Albit x Minhardi and Albit x Buffum 17 are being studied for inheritance of spike density and grain color as well as for resistance to four physiologic forms of bunt.

More than 300 spring wheats, mostly fifth and sixth generation segregates, were tested for bunt resistance. The inoculum was a composite sample of the 20 collections that comprised all physiologic forms available at the Pullman station. The 11 check rows of Jenkin averaged 70 per cent of bunted heads whereas 68 of the fixed hybrids were smut free.

Of 17 varieties of oats tested for resistance to covered smut Markton was the only one remaining smut free.

In continuance of the corn and sunflower selection and breeding project, 112 rows of corn and 62 of sunflowers were planted. Factors affecting yield and uniformity are being studied. Selection for earliness in soybeans was begun and a few rows of vetch and string beans were grown for observation and selection.

Rye Hybrids. (E. G. Schafer). The F_4 plants of the cross, *Secale cereale* x *S. montanum*, were grown in 1932. Several of these plants were grown in isolated plots in order better to control pollination. The original plantings of the F_2 and F_3 of this cross have been maintained. Both contained plants which have survived and produced seed each year. Natural selection based on ability to survive year after year is taking place in the earlier plantings. This natural selection may prove helpful in the study of perennial character.

Physiologic Forms of Bunt. (E. F. Gaines, A. M. Schlehner and C. S. Holton, in cooperation with the Division of Plant Pathology and Cereal Crops and Diseases, U. S. Department of Agriculture). Thirty varieties of winter wheat that were known to be resistant to one or more physiologic forms of bunt were used in the uniform smut nurseries at Pullman and Lind for testing resistance to local bunt. The inoculum used at each station was collected from commercial fields

in the vicinity of the station and presumably contained a composite of the forms present in 1931. It is evident that there were different physiologic forms of bunt in the two sections of the wheat belt.

Crop Rotation. (E. G. Schafer). The work of the rotation field now has been carried on for 14 years. That certain crops leave the land in better condition for succeeding crops than others again was shown this year.

Weed Eradication Studies. (E. G. Schafer and A. L. Hafenrichter, in cooperation with the Division of Chemistry). In order to determine the practicability on a field scale of chemical methods of treating bindweed that have proved most successful experimentally an area of several acres was treated with sodium chlorate during September, 1931. On examination during the summer of 1932 it was estimated that 98 per cent of the treated area was free from bindweed growth. Larger bindweed-free areas were found on hilltops than on north side lower levels. The greater destruction of bindweed on the heavier hilltop soil would seem to be due either directly or indirectly to soil conditions which may have affected vigor of bindweed growth or soil moisture relations. Methods for determining the lethal and residual effects of herbicides are being studied. Procedures relating to the rapid determination of relative and specific killing power of different chemicals are given special attention.

Competition between Forage and Grain Crops. (A. L. Hafenrichter in cooperation with the Office of Forage Crops, U. S. Department of Agriculture). Field plots are used to study the nature and degree of competition between alfalfa and sweetclover as forage crops and cereals and grasses as companion crops. The yield of alfalfa and sweetclover hay in the second year is determined by the relative vigor of the first year plants as conditioned by the different companion crops but not by the resulting stands. The effects of companion crops on the vigor and yield of the forage plants is modified by climatic conditions, cultural practices, and management of the land. Both total and seasonal distribution of rainfall affect the results, but the latter has the greater influence. Spacing of the companion crops has more influence than rate of seeding. Some varieties of a cereal are more desirable as companion crops than others of the same species. Crops previously grown on the land have an important bearing on the ease of securing stands and good yields with forage crops both when sown alone and when sown with other crops.

Alfalfa and sweetclover sown alone yielded considerably more hay than when sown with spring or winter grain. This result depends on the condition and management of the field previous to seeding. Peas compete less with forage crops than do cereals, but sufficient weed

growth may develop to reduce the quality and yield of the hay greatly. Barley and spring wheat reduce the stand and vigor of forage plants less than do oats or winter wheat. These two crops can be used to reduce the effects weeds may have on the forages.

Sweetclover Investigations. (A. L. Hafenrichter in cooperation with the Office of Forage Crops, U. S. Department of Agriculture). The nursery work with species, varieties, and strains of sweetclover continues. In triplicated row rows spaced at two-foot intervals, common white sweetclovers yielded three and one-fourth tons per acre (15 per cent moisture basis), dwarf sweetclovers two and one-fourth tons, and aberrant white types slightly over one and one-half tons. The average percentage leafiness for common, dwarf, and aberrant strains was 28.8, 35.1, and 38.5, respectively. Cultural practices and weather conditions at critical periods affect yield and leafiness of each type, but more specifically affect the strains within a type. Selections have been made to improve the quality and yield of promising strains in each group. The work was extended to include tests under irrigation.

Determinations of total nitrogen in the stems and leaves were made on all sweetclover strains under test. Significant correlations were secured between yield of nitrogen and total yield of hay for all types of sweetclover, but none was obtained between per cent leaf and yield of nitrogen. Composition is affected by the same conditions as those that modify yield and leafiness.

Studies in the progressive chemical changes in the roots and tops of sweetclover were made in connection with green manuring studies. Data were secured that indicated important criteria for the selection of types suited to variations in the management of the crop for this purpose.

The Maintenance of Organic Matter in Eastern Washington Soils. (S. C. Vandecaveye and L. C. Whetting). A study of the maintenance of organic matter in Palouse silt loam has been in progress for over 10 years. Different kinds of organic residues, applied alone and in combination with mineral fertilizers, have been compared under fallow and continuous systems of cropping. In addition, extensive studies of the effect of different crop rotations on the organic supply of the soil have been in progress. These rotations usually have had some soil building crop in the series, such as red clover, peas, sweetclover, alfalfa, or vetch. The results obtained for a 13-year period ending in 1931 have been prepared for publication.

With the exception of continuous cropping to winter wheat, none of the crop rotations have had any harmful effect on the organic supply of the soil. Some depletion was evident when wheat was grown continuously.

The variations in yield resulting from difference in the kind of season were greater than any differences caused by soil treatments.

The most profitable rotation during the years 1919-1931 inclusive was peas alternating with wheat. This rotation is probably limited, however, to regions of more than 20 inches of rainfall. The soil was not depleted by this system of cropping.

The fallow-wheat rotation gave the highest yields of any, but over a period of years it did not pay as well as certain others with a crop every year. The soil was not depleted under this system, but there was a serious loss of soil by erosion.

The use of certain green manure crops in the rotation appears to be a simple means of maintaining the productivity of the Palouse soil, because it is believed that the maintenance of a good supply of organic matter in the soil is the best assurance of continued productiveness. The work is being continued with slight modifications.

The work reported last year in connection with groups of microbes in the transformation of organic residue in the soil has been continued. Data were obtained from the use of straw, sweetclover, and pine needles on two different soils. One soil formed under semi-arid conditions is neutral in reaction and the other formed under humid conditions is acid in reaction.

The results show that there was a definite sequence of activity of different groups of soil microbes regardless of the kind of organic residue used, provided the nitrogen content of the organic residue was made the same at the start. Soil type, and possibly soil reaction, seemed to be important factors in the kind and rate of development of soil microbes.

Fertility Investigations of Washington Soils. (L. C. Wheeting and S. C. Vandecaveye). Fertilizer plot work in cooperation with county agents and Smith-Hughes teachers throughout the state has been continued. During last year a total of 88 fertilizer experiments, designed to determine what fertilizer elements are lacking, were conducted. In addition, six new experiments were tried, to determine the proper rates of application on soils whose fertilizer needs are known from previous work. A considerable number of experiments to test the usefulness of rock phosphate as a phosphorus carrier also were started. The total number of all cooperative plot experiments was well over 100.

The results of the first five years of work under this cooperative plan have been brought together for publication. They should prove of great value to farmers during these times, when low production costs are necessary to show a profit. Thus, it was found that a considerable number of soils are so limited by their environment as to

be naturally low producers. Fertilization of any kind on such soils was not found to be profitable. On the other hand, yields on some naturally high producing soils could not be raised sufficiently to justify the use of commercial fertilizers on ordinary crops. The great mass of soils in Washington, however, do respond to fertilizer treatments and give crop yields which are both profitable and gratifying to the grower. Quality of pastures and other crops can generally be raised. The limited space available in this report will not allow a detailed description of the results obtained, since there is such a wide diversity of soils in the state, each one with its own peculiar fertilizer requirements. The detailed report contained in Washington Experiment Station Bulletin 274 is available to all of the citizens of the state, and it is hoped that the fullest use will be made of it. This work is being continued, and it is planned to enlarge the studies on the proper rate of application of fertilizer on different soils.

Plant Composition as Influenced by Variations in Soil Types. (L. C. Wheating, S. C. Vandecaveye and G. O. Baker). In connection with the state-wide cooperative fertilizer plot work, a study is in progress to determine the effect of applications of fertilizers on the protein and mineral content of the cereal and forage crops grown on these plots. In addition, the study of the effect of the wide variations in climate, occurring in the state of Washington, on the composition of crops grown on similar soil types receiving identical fertilizer treatments has been continued for another year.

Some of the results on the effect of fertilizer treatments on the protein and mineral content of pasture grass and hay grown on six different soil types in western Washington have been compiled and are reported in detail in Washington Experiment Station Bulletin 274

It was found that with few exceptions the use of lime, or of phosphate and potash fertilizers, alone or in combinations, resulted in a greater protein, calcium, phosphorus, and potassium content of the pasture grass and hay. On an average the hay produced more dry matter per acre than pasture grass, but the latter removed from the soil approximately 35 to 40 per cent more nitrogen, calcium, phosphorus, and potassium than the hay. This explains in part why pasture is a better livestock feed than hay, but also indicates the heavy demand pasture makes on soil fertility and the need for maintaining the productivity of land in pasture. Lime treatments in combination with phosphate or potash fertilizers caused a marked change in the pasture flora on some soil types, in that weeds and worthless grasses disappeared and were replaced largely by clovers. Thus it appears that the use of fertilizer on pastures in western Washington results in better yields and quality of pasture grass and hay.

The Management of the Irrigated Soils and the Utilization of Irrigation Water and Its Influence on Soil Composition. These studies include two projects carried on in cooperation with the Irrigation Branch Station at Prosser. The details of these are given on page 58.

Changes Occurring in Irrigated Soils as a Result of Irrigation, Cropping and Fertilizer Treatments. (S. C. Vandecaveye and L. C. Wheeting). The various soil studies, including changes in soil reaction and changes in relationship of anions and exchangeable cations resulting from fertilizer treatments and irrigation practice, are being continued on a series of fertilizer plots in apple orchards on several different soil types in the Wenatchee irrigated district. One of these orchards has been fertilized for six years, and marked differences in yield and tree responses are evident on the variously treated plots.

The studies of the effect of fertilizer treatments on the growth and on the yield and quality of fruit, carried on in cooperation with the Division of Horticulture but closely correlated with the soil studies, are being continued.

The Effect of Various Factors on Inoculation and Nitrogen Fixation. (S. C. Vandecaveye). The results of studies of the relationship of nodulation and growth of alfalfa have been published in the Journal of the American Society of Agronomy, 24: 91-103. 1932.

The studies on the effect of various factors on non-symbiotic nitrogen fixation in soils of the Palouse series are being continued, and the results obtained to date will be prepared for publication this year.

Distribution of Nodule Bacteria Cultures. (S. C. Vandecaveye) The distribution of nodule bacteria cultures for seed inoculation has been continued as in previous years, but this year there was a marked reduction in the demand for these cultures. Laboratory cultures of the various species of nodule bacteria were sent to 655 individuals, the total amount being sufficient to inoculate seed for 5,060 acres. The acreage of the different legumes for which bacteria cultures were distributed is as follows: alfalfa, 2,585 acres; sweetclover, 186 acres; peas, 1,849 acres; vetch, 209 acres; red, white and alsike clover, 186 acres; beans, 17 acres; soybeans, 12 acres; and lespedeza, 16 acres.

DIVISION OF ANIMAL HUSBANDRY

H. Hackedorn in Charge

Feed Requirements for Fattening Calves, Yearlings, and Two-Year Olds for Pacific Coast Markets. (H. Hackedorn and Ralph

McCall). In order to arrive at a measuring stick that would serve as a guide for the amount of feed necessary to fatten beef steers of various ages, a lot of calves, yearlings, and two-year olds were fed at the main station. An extra-fancy finish or degree of fatness was not desired, but rather a carcass that goes regularly to the trade demanding good beef.

The condition of the cattle at the time they go into the feed lot plays an important part in the feed required to fatten them. The calves, yearlings, and two-year olds which were fed would be a little below the average degree of fatness found in range raised cattle. The calves had the advantage of being a little better quality than the yearlings or two-year olds. The calves weighed 436 pounds, the yearlings 549 pounds, and the two-year olds 743 pounds at the beginning of the test.

On full feed these cattle were fed a ration consisting of a grain mixture of 50 per cent cracked wheat, 23 per cent dry-rolled barley, 25 per cent dry-rolled oats, and chopped alfalfa hay. The two-year olds received a ration of approximately one pound of grain for one pound of hay, the calves 30 per cent more grain than hay, and the yearlings 10 per cent more grain than hay.

The calves and yearlings required 150 days and the two-year olds 120 days to reach an acceptable market finish, gaining on the average of 2 pounds, 1.87 pounds, and 2.29 pounds per day respectively. The calves required practically 1300 pounds of grain and 1000 pounds of hay per head to finish them; the yearlings 1500 pounds of grain and 1400 pounds of hay; and the two-year olds 1400 pounds of grain and 1500 pounds of hay. These figures may serve as a guide for the amount of feed necessary to fatten cattle to a degree of finish sufficient to top the market, providing the cattle are good quality steers.

Wheat Hay Versus Alfalfa Hay as a Feed for Two-Year Old Steers. (H. Hackedorn and Ralph McCall). The relative value of wheat hay as compared with alfalfa hay was tested as a feed for fattening two-year old cattle. The same grain mixture described in the previous section was fed to two lots of steers. The wheat hay was the Albit variety and was cut a little riper than is normally supposed to be most desirable for cattle hay, the grain being almost mature at the time of cutting.

The lot of cattle on wheat hay did very well the first 60 days. After this period the ratio of $1\frac{1}{4}$ pounds of hay for every pound of grain fed was not satisfactory. With the alfalfa lot the grain fed was kept constant. The cattle receiving wheat hay were fed all the wheat hay they would eat. It required 1354 pounds of grain and 1230 pounds of wheat hay per head to fatten this group of two-year old steers which, at the beginning of the experiment, weighed 747 pounds. They

made an average daily gain of approximately 2 pounds per head per day for 120 days. The group fed on alfalfa hay required practically the same amount of grain, but ate 1500 pounds of chopped alfalfa hay. They made a daily gain of 2.29 pounds per head per day for the 120 days. These steers made more economical gains than those receiving the wheat hay and carried a little higher degree of finish at the time of sale.

Grains for Fattening Lambs. (H. Hackedorn, H. P. Singleton and J. Sotola. Conducted at the Irrigation Branch Station, Prosser). Turkey Red, a hard red winter wheat; Jenkins, a soft white spring wheat; Baart, a hard white spring wheat; barley; oats; locally grown corn; and Thayer's yellow corn were tested as grains for the feeding of lambs.

The results of the 65-day feeding trials with groups of 25, 70-pound lambs show very little difference in the three varieties of wheat. The Baart was slightly more efficient in these tests. The barley was a little more efficient than the wheat. Thayer's yellow corn was quite a little superior to the local corn, both ranking above the small grains. Oats were the least satisfactory as the sole grain feed. All grains were fed whole at the rate of $1\frac{1}{4}$ pounds per head per day, in addition to all the chopped hay they would consume, which was approximately 16 pounds per head per day.

Processing Wheat, Oats, and Barley for Fattening Lambs. (H. Hackedorn, H. P. Singleton and J. Sotola. Conducted at the Irrigation Branch Station, Prosser). Baart wheat, barley, and oats were fed to groups of lambs similar to those described above as whole grain, steam-rolled, and ground. The hard spring Baart wheat was not improved any as a feed for fattening lambs either by steam-rolling or by grinding. Barley was similar to the wheat this season. Last season slightly better results were obtained with the rolled barley. Oats were seemingly improved by steam-rolling this year. The results from grinding this year were practically the same as in the lot receiving rolled oats.

Comparative Values of Corn Silage, Cull Potatoes, and Cull Apples as a Feed for Fattening Lambs. (H. Hackedorn, H. P. Singleton and J. Sotola. Conducted at the Irrigation Branch Station, Prosser). Six lots of lambs similar to those described above were fed in this group. The cull apples ranked first, cull potatoes second, and corn silage last as succulent feeds for the fattening of lambs. Results show that the cull apples and cull potatoes when fed at the rate of one pound per head per day chopped were very similar in their feed values. In previous years' results potatoes have been a little superior to apples. Both potatoes and apples were superior to corn silage during the three-year tests.

One lot of 20 lambs was fed $1\frac{1}{2}$ pounds of potatoes to compare with one pound of potatoes. The heavier feeding of potatoes, although practically equivalent amounts of grain and hay were consumed, did not produce any more favorable results than one pound of potatoes.

Another group of lambs was fed whole potatoes rather than chopped potatoes at the rate of one pound per head per day. In comparing the two lots there was no advantage from chopping the potatoes. It required approximately 330 pounds of grain, 400 pounds of hay and 300 pounds of silage, apples, or potatoes to produce 100 pounds of gain as compared with 385 pounds of grain and 510 pounds of chopped hay for the group receiving no succulent feed.

The Biological Value of the Proteins in Alfalfa Leaves and Stems, and Digestion Coefficients of Nutrients in Stems and Leaves. (J. Sotola). The three-year study includes work with the first, second, and third cuttings of northern-grown common alfalfa, produced on irrigated land. One cutting of hay was studied each year as follows: (a) the per cent by weight of stems and leaves was determined, (b) coefficients of apparent digestibility of the organic nutrients were determined when whole hay, leaves, and stems were fed as sole rations, (c) the biological values of the proteins in nine samples of hay, including the stems, whole hay, and leaves of each of the three cuttings were determined, (d) calcium and phosphorus balances were completed in an effort to determine the value of the stems and leaves in all three cuttings as sources of these minerals.

From two-thirds to four-fifths of the plant protein was found to be contained in the leaves. The alfalfa leaves exerted a marked diuretic effect upon lambs when fed as the sole ration.

The leaves also contain from 71 to 85 per cent of the calcium and 46 to 79 per cent of the total phosphorus in the alfalfa plant. In an average of results, the dry matter of the leaves was 66 per cent digestible and of the stems, 47 per cent. The crude protein of the leaves was 74 per cent digestible and of the stems, 51 per cent. The crude fibre of the leaves had a coefficient of 55, and of the stems, 38.

The average content of total digestible nutrients in the stems of all three cuttings was 42.85 per cent and in the leaves, 61.11 per cent.

When stems alone were fed the lambs stored 4.3 per cent of the nitrogen, and when leaves alone were fed, 16.3 per cent. The biological value of the proteins in the stems was found to be higher by one-third than that of the leaves.

Lambs, on the average, fed alfalfa stems stored 1.3 grams of calcium and .5 grams of phosphorus during 10-day periods. When alfalfa leaves were fed the storage was much greater, being 24.1 grams of calcium and 7.3 grams of phosphorus.

The Effect of Plant Maturity on the Nutritive Value of Markton Oat Hay. (J. Sotola). During the crop year of 1931, samples of Markton oat plants cut in the milk, medium dough, and ripe stages were studied chemically. The season was dry and the oat kernels lacked the customary plumpness. On a 10 per cent moisture basis the protein percentage of 9.30, 9.20, and 9.18 was obtained for the milk, dough and ripe stages respectively, showing only a slight decrease. The fibre content of 28.32, 24.41, and 24.12 in the same order shows a marked decrease from the milk to the medium dough stage and then remains stationary. The percentage decrease is attributed to the increasing amounts of carbohydrates accumulating in the heads. Calcium-phosphorus ratios of 1.13 to 1, 1.43 to 1, and 1.72 to 1 were determined for the milk, medium dough, and ripe stages, respectively.

Markton oat hay from plants in the milk stage was found to contain 5.88 per cent digestible protein and 50.15 per cent total digestible nutrients. At the dough stage the hay contained 5.80 per cent digestible protein and 47.69 per cent total digestible nutrients. The hay from ripe plants excelled all others with a content of 6.40 per cent protein and 54.56 per cent total digestible nutrients.

Steam-rolled Barley for Pregnant Ewes. (J. Sotola and H. Hackerdorn). Six Rambouillet ewes, two and three years of age, were fed rations of low-grade hay, hay and whole barley, and hay and steam-rolled barley in metabolism crates. Coefficients of apparent digestibility were reported in the Forty-first Annual Report. The data for calcium and phosphorus balances were not completed at that time.

There is a certain masking effect of the true utilization of feed minerals in advanced pregnancy. Such an effect is progressively greater and must be highly correlated with increase in size and therefore the nutritional requirements of the fetus.

Ewes fed alfalfa hay stored 6.49 grams of phosphorus per head every 10 days. When steam-rolled barley and the same grade of hay were fed there was a loss of .55 grams, and when whole barley and alfalfa hay were fed, the loss was 6.23 grams.

All ewes lost calcium, irrespective of the type of ration fed. Those on hay alone lost 7.60 grams of calcium every 10 days. When steam-rolled barley and hay were fed the loss was 31.40 grams, and when whole barley and alfalfa were fed, the loss was 40.61 grams.

The calcium-phosphorus ratio varied in the same lot of barley from 1 to 3 for the whole to 1 to 2.7 for the steam rolled. The alfalfa hay fed had ratios of 5.8 to 1, 6.3 to 1, and 4.7 to 1 for the hay fed in trials with whole barley, steam-rolled barley, and hay alone.

The Nutritive Value of Range Grasses. (Ralph McCall). Two years' study on the seasonal variation in nutrient content of Blue

Bunch Grass (*Festuca idahoensis*) shows that this grass has an exceptionally high feed value during the green stage. The early spring growth is high in moisture content, but contains a higher per cent of protein, pound for pound, than at any other stage. As content of protein is indicative of feed value, this fact is significant. As this grass matures, its percentage content of feed nutrients decreases rapidly, but is counterbalanced by the increase in volume of forage. The mature grass changes very little in composition during the fall and winter months.

Digestion trials with mature Blue Bunch Grass, Blue Bunch Wheat Grass (*Agropyron spicatum*), and a third type of range feed common in the Yakima Valley composed principally of Blue Bunch Wheat Grass with about 10 per cent of other range forages indicate a feed value little better than timothy hay. However, the mixture proved superior to the pure varieties.

The entire mature plant was used in these digestion tests. Further study with the leaves and tips of the stems may show a higher feed value for these grasses. The study completed, however, shows the necessity of supplementing the winter forage with other feeds for ewes lambing before the new spring growth starts.

DIVISION OF CHEMISTRY

J. L. St. John in Charge

Characteristics of Maturing Apples. (J. L. St. John). The comparative study of Delicious apples and mutations of the Delicious has been continued to determine any difference in composition and quality. Additional work has been done on the composition of the alcohol insoluble portion of apples. This included a study of pentoses and higher carbohydrates. Work is also being done on the isolation and identification of different carbohydrate fractions.

Chemistry of Oil Sprays. (Kermit Groves). The chemical properties of many kinds of fish oil have been studied to determine the correlation between their properties and the effectiveness of the fish oil in increasing the spreading and adherence of lead arsenate sprays on fruit. At one time field tests seemed to show marked differences in the efficiency of different varieties of fish oil. An effort was made to identify the constituents of the fish oils that were most effective in promoting adherence and spreading of lead arsenate. Field tests do not show conclusively that any one variety of fish oil is superior to the others. Ten brands of commercial lead arsenate were examined

and all were found to be composed chiefly of lead acid arsenate with small amounts of basic arsenates. All brands had approximately the same composition.

Nature of Watery Whites in Eggs. (J. L. St. John and A. B. Caster). Results of study of a method for the determination of bound water in egg whites were published in the *Journal of the American Chemical Society* 53: 4014. It is shown that all of the free water is frozen at a temperature of -12.5°C ., no more water being frozen at a temperature as low as -35.0°C . The amount of bound water in the thick portion of egg white was determined. An improved formula for the calculation of free water is presented. A study is being made of the relative amount of bound water in the thick and thin portions of egg whites. A quantity of data is accumulating on this subject. Data on the relative value of the thick and thin portions of egg white for the baking of angel food cake were published cooperatively with the division of Home Economics in the *Journal of Home Economics* 23: 1151. It was shown that the thin portion gives a larger volume of cake than the thick, that the white should be beaten at room temperature or above, that storage has little effect on its value for this purpose. These results offer evidence that for cake making watery whites are more desirable than firm whites. Additional data also have been obtained on the nitrogen distribution in the thick and thin portion of the white.

Arsenical Residue on Fruit. (Kermit Groves). The removal of arsenical residue is complicated by some oil spray combinations and it has been necessary to take this into consideration in spray programs. This Division has cooperated with the Divisions of Horticulture, Entomology and Engineering in residue removal experiments. Apples that have been sprayed with various combination sprays were given different chemical and mechanical treatments in a specially designed washer and were afterwards analyzed for arsenic. Several of these treatments seemed to be satisfactory.

Poultry Nutrition. (J. L. St. John, Otto Johnson, Clayton Kempf and Virginia Hefty, in cooperation with the Division of Poultry Husbandry). Further results on the protein requirements of poultry were published in *Poultry Science* 11: 45, showing that at least 15 per cent of protein should be included in a chick ration while from the twelfth to the twenty-sixth week less protein may be used. A high protein level was not injurious to the birds. A paper was also published in the *Journal of Nutrition* 5: 267 describing a method of determining the biological value of protein. Necessary data on the endogenous and metabolic nitrogen elimination were given. This method makes possible the measurement of the biological value of feeds for poultry, while previously such a value could only be meas-

ured with mammals. Using this method the biological value of different fish meals has been determined. The biological value of such a ration is high and good growth is secured with a ration supplemented with fish meals. A protein level of 15 per cent seems to be optimum for chicks up to 12 weeks of age. This work has been continued to the sixty-second week, including therefore seasonal variations in requirements and the effect on egg production. Work also is being done on the effect of changing the protein level when chicks are 10 weeks of age.

A study has also been made on the relative value of various domestic and foreign meat meals. Mineral levels in their relation to protein metabolism are important. Mineral balance studies indicate that mineral levels are more important than the ratio between elements. Work on the standardization of the method for ash determination for use in this work also has been done.

Bindweed Eradication. (J. L. St. John and F. O. Gibson, in cooperation with the Division of Agronomy). A method for the determination of catalase in plant material has been developed and is being applied to the measurement of the effectiveness of weed eradication.

Fish Oils as a Source of Vitamin D. (J. L. St. John and Arthur Brunstad, in cooperation with the Division of Poultry Husbandry). The efficiency of different fish oils as sources of vitamin D is being determined when these oils are fed at different levels and under different conditions. The effect on growth, calcification, egg production and quality of eggs is being studied. The work is well under way, but not sufficiently near completion for publication.

Service Work. In addition to cooperative work with the other divisions an increased amount of analytical service for other divisions of the experiment station has been done. Many samples are received from private individuals which cannot be analyzed because of lack of time and funds. Qualitative tests are made on samples, but quantitative analyses cannot ordinarily be made unless a fee is received to cover the cost of the work.

Some Needs of the Division. Additional help and funds should be provided for work upon some of the projects discussed above and for work on other problems. An intensive study of the chemical utilization of cull and waste apples and apple pomace should be made in the very near future. A study of the utilization of soft wheat flours and methods for more accurately measuring the value of soft wheat flours for pastry purposes should be undertaken.

STATE CHEMIST

J. L. St. John in Charge

The State Chemist's work has been of a nature practically identical with that of last year, and results and recommendations made in last year's report apply equally well this year. The following quotations from the last report apply to this year's work:

"Analysis is made of official samples received from the inspectors of the State Department of Agriculture. The larger part of the work has been on samples of commercial feeding stuffs, together with work on foods and commercial fertilizers.

"The feed law and rulings require the manufacturer to guarantee a minimum per cent of protein and fat and a maximum per cent of crude fiber and ash, with a statement of the per cent moisture. It also stipulates that the crude fiber shall not exceed 10 per cent

"The results obtained reemphasize the fact that there should be additional facilities for enforcing the law. A law including a registration fee and tag tax for feeds and fertilizers sufficient to handle all costs of inspection and analysis so that the funds available would automatically increase as the amount of work increases is highly desirable. Such a method would be similar to that employed by other states. It should provide sufficient funds for analysis of at least one to two samples of each brand of feed, fertilizer and insecticide registered and sold in the state. Funds should also be provided for greatly increased work on foods. Legislative provisions should be made for the publication of results obtained by the State Chemist, which is not now permissible.

DIVISION OF DAIRY HUSBANDRY

E. V. Ellington in Charge

Bacterial Content of High Quality Milk. (C. C. Prouty and E. V. Ellington). A qualitative and quantitative study of the bacterial flora of low count milk was reported in Scientific Paper 190, see page 78

Qualitative and quantitative studies are being made of the bacterial flora of raw and pasteurized milk from a commercial market milk plant. The numbers of acid forming proteolytic and inert and alkali forming bacteria are determined prior to and after pasteurization and in both raw and pasteurized samples after 24 and 48 hours of incubation at 70° F. Approximately 15 per cent of the pasteurized samples thus far studied have developed pronounced off flavors within a period of 48 hours without the production of titratable acidity in excess of 0.25 per cent.

A survey of about 25,000 plate counts of market milk from all sections of the state of Washington shows that approximately 55 per cent of the market milk reaches the pasteurizing plant with a bacterial count of less than 10,000 per cc. Approximately 80 per cent of this milk has a plate count of less than 25,000 per cc.

The Effect of Temperature of Storage of Acidophilus Milk Upon the Number of Viable Organisms. (C. C. Prouty and H. A. Bendixen). A quantitative study was made of the numbers of viable *Lactobacillus acidophilus* organisms remaining in sherbets made from acidophilus milk. The results appear in Scientific Paper 235, "The Viability of *Lactobacillus Acidophilus* as Affected by Freezing in a Sherbet Mixture."

The Relationship of Physical Characteristics of the Cow's Mammary System to Production. (C. C. Prouty and E. V. Ellington). A study has been made of the brom thymol blue reaction, the catalase content and the leucocyte count of 962 samples of freshly drawn milk from individual quarters of approximately 50 cows. As the leucocyte count increases, a larger percentage of the samples react abnormally to both the catalase and brom thymol blue tests.

Of 513 samples having leucocyte counts of less than 100,000 per cc., 11.0 per cent had a catalase content in excess of normal and 1.0 per cent showed an abnormal reaction to the brom thymol blue test. Of 93 samples having counts in excess of 1,000,000 per cc., 97 per cent and 82 per cent respectively reacted abnormally to the catalase and brom thymol blue tests

A Study of the Correlation between Cream Quality as Determined by Various Tests and Butter Quality. (H. A. Bendixen and C. C. Prouty.) The results of this study appear in Washington Experiment Station Bulletin 269, "Grading Cream for Butter Making."

Dried Apple Pomace for Milk Production. (J. C. Knott, R. E. Hodgson and E. V. Ellington, in cooperation with the Western Washington Experiment Station, Puyallup, and the Bureau of Dairy Industry, U. S. Department of Agriculture). Two feeding trials were conducted in which dried apple pomace was compared to dried beet pulp. Ten producing cows were used in each. The animals were divided into two groups of five cows each, as nearly alike as possible. The double reversal method was used with preliminary periods of one week and periods of comparison of four weeks. Both the apple pomace and the beet pulp were soaked and fed as succulent feeds. The average daily consumption of dried apple pomace per cow was 9.31 pounds and of dried beet pulp 9.16 pounds. In addition to pomace and pulp, the animals received alfalfa hay and a grain mixture. The pomace groups produced approximately 92.5 per cent as much milk as the

pulp group. The results of this study appear in Washington Experiment Station Bulletin 270, "The Feeding Value of Dried Apple Pomace for Dairy Cattle."

The Apparent Digestibility of Dried Apple Pomace. (J. C. Knott, R. E. Hodgson and E. V. Ellington in cooperation with the Western Washington Experiment Station, Puyallup, and the Bureau of Dairy Industry, U. S. Department of Agriculture). In a digestion experiment with three two-year old Holstein heifers dried apple pomace was used as the sole source of feed. This experiment consisted of a 10-day preliminary period and a 14-day collection period.

The heifers ingested an average of 25366 grams of dry matter each per day. Each of the three heifers lost weight throughout the experiment. The outgo of nitrogen was greater than the intake in each case. The apparent digestibility of the nutrients in the dried apple pomace was as follows: dry matter 72 per cent, crude protein 00 per cent, crude fiber 56 per cent, ether extract 37 per cent, nitrogen-free extract 87 per cent. The results of this study appear in Washington Experiment Station Bulletin 270, "The Feeding Value of Dried Apple Pomace for Dairy Cows."

Raising Dairy Calves on Dried Skim Milk. (J. C. Knott, R. E. Hodgson and E. V. Ellington in cooperation with the Western Washington Experiment Station, Puyallup, and the Bureau of Dairy Industry, U. S. Department of Agriculture). Thirty-one dairy heifers were raised on a dry calf meal containing 25 per cent of powdered skim milk. These heifers were normal in size, thrifty and vigorous at six months of age and in no way distinguishable from heifers raised in the usual way on separated skim milk. The results appear in Washington Experiment Station Bulletin 273, "Raising Dairy Calves with Dried Skimmilk."

The Determination of Apparent Digestibility by Modified Procedures. (J. C. Knott, R. E. Hodgson and E. V. Ellington in cooperation with the Western Washington Experiment Station, Puyallup, and the Bureau of Dairy Industry, U. S. Department of Agriculture). A simplified method of determining apparent digestibility has been used with considerable success by various investigators. With one exception no results with large animals have been reported thus far. In conjunction with the ordinary method of determining apparent digestibility, two experiments were carried out by modified procedure. In these both the naturally occurring silica and the naturally occurring iron were used as the indices. Results obtained by this method varied considerably from those obtained by the ordinary procedure.

A Method for Determining Calcium in Urine. (Harold Gerritz and J. C. Knott). The method is a modification of the standard volumetric

oxalate method. Oxidizing agents are used which make it possible to bring the urine sample to dryness in a short time. The oxidation is then completed by heat, the ash is taken up with 1-4 HCL and hot water. The solution is filtered and the calcium precipitated and determined according to the standard oxalate method.

The Efficiency of Rotational Grazing in Western Washington. (R. E. Hodgson, M. S. Grunder and J. C. Knott, in cooperation with the Western Washington Experiment Station, Puyallup, and the Bureau of Dairy Industry, U. S. Department of Agriculture). The procedure followed in this experiment was given in the Director's Forty-first Annual Report. The results of two seasons on the comparison of the relative efficiency of continuous and rotational grazing of pastures have been obtained. The average number of cow days per acre during the 1931 and 1932 grazing season was 269 and 316 respectively for the continuously grazed pasture as compared with 268 and 315 respectively for the rotational grazed pasture. The cows on the continuous grazed pasture produced a total of 13,857.1 pounds of 4 per cent fat corrected milk in 1931 and 22,720.8 pounds in 1932, while equal numbers of cows on the rotational grazed pasture produced 15,074.2 pounds and 21,893.5 pounds respectively. The average daily gain in live weight of the cows subjected to continuous grazing during the 1931 and 1932 seasons was .56 pounds and .54 pounds, while that of the cows subjected to rotational grazing was .75 pounds and .55 pounds respectively. In 1931 the cows on the continuously grazed pasture obtained 86.9 per cent of their total digestible nutrient requirements from pasture as compared with 90.0 per cent for the cows subjected to rotational grazing. This project will be continued.

Investigations of the Carrying Capacity of Pure Stands of Pasture Grass—Reed Canary Grass. (R. E. Hodgson, M. S. Grunder, and J. C. Knott, in cooperation with the Western Washington Experiment Station, Puyallup, and the Bureau of Dairy Industry, U. S. Department of Agriculture). Two years' results have been obtained on the carrying capacity of a two-acre pasture of Reed Canary grass. During the seasons of 1931 and 1932 this pasture maintained milking cows at the rate of 298 and 261 cow days per acre. The pasture was grazed rotationally. The total production of 4 per cent fat corrected milk for the two seasons was 15,528.4 pounds and 22,240.6 pounds. The average daily gain in live weight of the experimental subjects was .81 pounds and .62 pounds respectively. The total amount of digestible nutrients required for maintenance, gain in live weight, and milk production for the 1931 season was 1,208.77 pounds of which 87.0 per cent was furnished by pasture.

The Feeding Value of Artificially Dried Forage Crops. (R. E. Hodgson and J. C. Knott, in cooperation with the Western Washing-

ton Experiment Station, Puyallup, and the Bureau of Dairy Industry, U. S. Department of Agriculture).

1. THE APPARENT DIGESTIBILITY OF, AND NITROGEN, CALCIUM AND PHOSPHORUS BALANCE OF DAIRY HEIFERS ON ARTIFICIALLY DRIED PASTURE HERBAGE. The grass used in this metabolism trial was dried in an experimental oven dryer at a temperature ranging from 100° to 200° F. It consisted of mixed pasture grasses and clovers. The material was fed as a sole diet to three dairy heifers for a 10-day preliminary period and a 15-day collection period. The usual methods outlined for conducting a metabolism experiment were employed. The chemical composition of the pasture herbage was as follows: crude protein 24.64 per cent, nitrogen-free extract 39.19 per cent, ether extract 3.50 per cent, crude fiber 18.09 per cent, ash 11.18 per cent, calcium .78 per cent, and phosphorus .65 per cent. The apparent digestibility coefficients obtained are: protein 74.92 per cent, nitrogen-free extract 74.55 per cent, ether extract, 21.90 per cent and crude fiber 72.68 per cent. The average daily nitrogen balance was —.63 grams. The average daily balances of calcium and phosphorus were —5.98 grams and 1.53 grams respectively. The heifers made an average daily gain in live weight during the collection period of 1.32 pounds.

2. THE VITAMIN D CONTENT OF GREEN, ARTIFICIALLY DRIED AND SUN-CURED PASTURE HERBAGE. Eight lots of 10 rats each were maintained for a period of seven weeks on a basal vitamin D free diet plus varying amounts of green, and artificially dehydrated grass. One lot was used as a negative control receiving only the basal diet. Another lot, the positive control, received the basal diet, plus three drops of vitamin D per week per animal. The degree of calcification (percentage of ash in the green femur bone) was used as an indication of the vitamin D potency of the feed in question. It was found that rats receiving 3, 6, and 9 per cent of green grass (dry matter basis) in their daily ration had on an average practically as great a percentage of ash in their fresh femur bone as did the positive control group and considerably more than the negative control group. There appears to be little difference in the percentages of ash in the fresh femur bones of rats receiving, in addition to their basal diet, green grass as compared with those receiving artificially dried grass preserved under our methods of drying. This phase of the work, however, has not been completed. The project is being continued.

Proved Sire Project. (R. E. Hodgson and J. C. Knott in cooperation with the Western Washington Experiment Station, Puyallup, and the Bureau of Dairy Industry, U. S. Department of Agriculture). The purpose of this experiment is to breed a herd of pure bred Holstein-Friesian cattle, that is pure in its inheritance, for a high level of milk and butterfat production. It is expected that this will be accomplished

through the continuous use, generation after generation, of sires that have proved through their daughters to have inheritance that will enable them to transmit high producing ability to their offspring. All females dropped in the herd are being raised through their first lactation under uniform experimental conditions. Measurements of growth, gain in live weight, feed consumption and production are being kept on each animal. Daughter and dam comparisons are being made to determine the transmitting ability of the bulls in use. The proved sire, King Paul Helena Colantha, 407735, now being mated to females in the herd has to date 14 daughters showing a 16.8 per cent increase in their average yearly butterfat production over their dams.

Official Testing. (J. C. Knott). During the year ending June 30, 1932, there was a monthly average of 24.3 breeders with cows on official test. The average number of cows tested per month was 241.6. The volume of testing work was approximately the same as for the previous year. Herd Improvement Registry testing showed an increase over the previous year.

DIVISION OF ENTOMOLOGY

R. L. Webster in Charge

Oil Sprays. (R. L. Webster, Anthony Spuler¹, and James Marshall in cooperation with the Divisions of Horticulture and Chemistry). Studies on the value of combination oil sprays, including fish oil as well as mineral oil, are continued at the experimental orchard and field laboratory at Wenatchee.

MINERAL OILS Because of extremely severe infestation with the codling moth during the 1932 season, some striking comparisons could be made between plots subject to various treatments. Where the oil-lead arsenate combination was used in the early cover sprays, the most satisfactory control of codling moth was obtained. The best plot in the experimental orchard from the standpoint of worm control was sprayed with three pounds of lead arsenate, to which was added, in the first three cover sprays, a mineral oil emulsion containing .8 per cent actual oil and a commercial spreader. Lead arsenate alone was used in the succeeding three cover sprays. Other plots also showed the greater efficiency of the oil-lead arsenate combination when used in the early cover sprays as compared to a spray schedule of lead arsenate alone at the rate of three pounds to 100 gallons of water.

The nicotine-oil combination, when used in the late cover sprays, has given excellent results for several years when directed especially

¹ Deceased.

against the codling moth. Although worm damage was more severe than usual in the experimental orchard in 1932, a comparison between plots in which oil-nicotine was used in the last two cover sprays with the nearest plot in which lead arsenate (3-100) was used throughout the season indicates that both treatments are approximately equal in their efficiency. Where mineral oil was combined with pyrethrum in the last two cover sprays, heavy damage by codling moth resulted. Evidently this combination is far less efficient than lead arsenate alone under the severe conditions of the past season.

Where mineral oil was used with Cubor (an insecticide containing pyrethrum and rotenone) in the first and second cover sprays, lead arsenate alone in the third and fourth, and mineral oil and Cubor again in the fifth and sixth cover sprays, the infestation was especially severe. The final count showed 881 worms per 100 apples, the least efficient protection in the whole orchard. Evidently this combination is of little value in codling moth control. The failure of rotenone to check the codling moth is in line with the results of previous trials with this material.

FISH OILS For several years, excellent results have been obtained when fish oil has been added to lead arsenate at the rate of a quart of fish oil to 100 gallons of spray material. This oil has been obtained from a local dealer in Wenatchee and was said to be herring oil. Chemical analyses, however, indicate that the material may actually have been dogfish oil or a mixture of fish oils.

Differences in fish oils have been studied and some are more desirable for use with lead arsenate than others. A slow-drying oil is particularly effective in helping to maintain successive applications of lead arsenate on the fruit. Sardine oil was found undesirable in this respect, and its use also resulted in reduced arsenical deposit on the fruits. A high arsenic deposit per unit on sprayed apples is absolutely essential in every case where fish oil is combined with lead arsenate in order to increase the efficiency of that material.

Some difficulty was encountered in mixing fish oils. It is thought that the removal of part of the stearines might facilitate mixing, especially in cold weather. The effect of such removal on arsenic deposit is being studied. In general, combinations of fish oils with lead arsenate in the early cover sprays gave satisfactory results in codling moth control, especially under the severe conditions of 1932. Using the alkaline washes, these combination sprays have not been especially difficult to remove.

Toxicity of Arsenicals. (R. I. Webster, Anthony Spuler¹ and James Marshall). A comparison of three years of laboratory studies

¹ Deceased.

at Wenatchee, in which the oil-lead arsenate combination was sprayed on apples, indicates a decreasing effectiveness of the lead arsenate in stopping the entering worms. At the same time that the apples were sprayed, duplicate samples were turned over to C. D. Dolman, chemist employed by the Wenatchee Valley Traffic Association, for analysis of the coverage. The analyses showed a uniform deposit of arsenic during the three years, running between 60 and 65 micrograms per square inch of apple surface. With a film type of coverage, this has generally been considered as sufficient to stop most of the worms. In 1930 an average control of 73.0 per cent was obtained. This dropped down to 60.0 per cent in 1931 and to 36.0 per cent in 1932. Not only this, but other laboratory tests with various lead arsenate combinations in 1932 resulted in a decreased control as compared to previous years.

Procedure was the same in all three years, except that during the last two years the sprayed apples were placed in a constant temperature chamber at 80 degrees for 24 hours, long enough for the eggs to hatch. The same brand of lead arsenate and commercial oil was used in all three years' work.

Certain of the fluorine compounds were compared with lead arsenate and found to be fairly efficient when used with mineral oil or fish oil. Previous investigations had shown that these materials were inferior to lead arsenate when used alone. Potassium fluo-aluminate, three pounds to 100 gallons of water, to which was added fish oil at the rate of one quart to 100 gallons, gave results even better than the nearest straight lead arsenate check plot in the orchard, although the difference was only about 10 per cent. Combinations of a natural cryolite with fish oil on Jonathans also gave satisfactory results.

Following the more general use of fish oils and mineral oils in combination sprays, there has been a tendency to use alkaline washes to remove arsenic from apples wherever removal has become difficult. Most of the fruit treated with lead arsenate and mineral oil or with lead arsenate and fish oil has been cleaned with the alkaline washes without great difficulty. Under these circumstances, there will be less of a tendency on the part of the fruit grower to turn toward non-arsenicals in codling moth control during the late season applications for second brood worms.

Nicotine tannate, when combined with emulsified mineral oil in the last two cover sprays, gave protection equal to a straight lead arsenate treatment. The oil-pyrethrum combination was inadequate under the heavy worm attack late in the season.

Potato Flea Beetle. (Arthur J. Hanson, Western Washington Experiment Station). Injury by the potato flea beetle on potatoes has resulted in considerable loss in western Washington during the past

seven years. It has been so serious in Grays Harbor, Thurston, Pacific, Lewis and Cowlitz counties that potatoes of salable quality cannot be grown.

Studies have been made during the year of the life history, the increase of foliage injury during the summer, the relationship between the dates potatoes are planted and the amount of tuber injury that results, varietal resistance, host range, and insecticides which may be used in controlling the insect. All of the more promising insecticides that may be used for flea beetle control were included in the experimental work. Calcium arsenate and lime (1-4) and barium fluosilicate and diatomaceous silica (1-1) show the most promise.

DIVISION OF FARM MANAGEMENT AND AGRICULTURAL ECONOMICS

Rex E. Willard in Charge

Types of Farming in Washington. (Rex E. Willard and Neil W. Johnson¹ in cooperation with the Bureau of Agricultural Economics, U. S. Department of Agriculture). An analysis of climate, soil, topography, production of crops and livestock, prices and other data is being made to determine the type-of-farming areas of the state. Data of many agencies are being used such as those of the U. S. Bureau of Soils, U. S. Geological Survey, U. S. Census, U. S. Forest Service, U. S. Weather Bureau and others. The report of the study will be largely in the form of maps of the state, showing various facts and conditions, many of them in detail to the extent of localization by precincts. The report will depict the trends of production, prices, etc., for each type-of-farming area. Publication of results is expected in 1933.

An Economic Study of Farming in the Non-Orchard Area of the Yakima Valley. (E. F. Landerholm, Byron Hunter² and Rex E. Willard in cooperation with the Bureau of Agricultural Economics, U. S. Department of Agriculture) This study was undertaken to determine types of farm organization and management best adapted to the physical and market conditions of the area. However, as the study proceeded, a number of conditions and problems were encountered which have modified this objective. Among these are the following: the heterogeneous physical character of the soil of the

¹ Associate Agricultural Economist, Bureau of Agricultural Economics, U. S. Department of Agriculture.

² Agricultural Economist, Bureau of Agricultural Economics, U. S. Department of Agriculture.

area; the variation in the seepage and alkali problem from farm to farm; variation of the ravages of the wire worm, especially on the potato crop; and the wide prevalence of root rot and other causes which thin the stand and reduce the yield of the alfalfa crop.

A report is being prepared which will describe the area, trace the development of the district and show the changes which have taken place in the use of land for various purposes; it will show the changes in the relative importance of livestock kept from year to year, discuss the causes of these changes, and point out some of the chief agricultural problems of the area

The Economic Relation of Tractors to Farm Organization in the Grain Farming Areas of Eastern Washington. (E. F. Landerholm). Comparative costs and physical input requirements for hilly as compared to level land for the various operations performed with tractors have been ascertained for the wheat areas of eastern Washington as has also the effect of width of equipment, number of hours of tractor operation per year and other significant factors relating to tractor farm organization. All the field work and the major portion of the tabular material on this project have been completed.

Trends in the Apple Industry. (C C Hampson) A thorough analysis of production, varieties, apples marketed, exports and price trends has been made. The trend of planting of the leading varieties has been depicted in detail both for the barrel states and the box states as well as for Washington by itself. Detailed information for local producing areas within the state has been portrayed. The apple tree censuses of the State Department of Agriculture, of the Bureau of Agricultural Economics, U. S. Department of Agriculture, and of the Bureau of the Census, were some of the sources of information. The report will go to press early in 1933.

Some Economic Aspects of the Cold Storage of Washington Apples. (C C. Hampson) This study is an attempt to determine the adequacy of cold storage space for apples in Washington and the desirability of greater or less storage space at the terminal markets. The amount of storage space available has been determined and the relationship of such space to demand is being evaluated. The data necessary for this report have been secured and the results will be ready for publication early in 1933.

A Study of Apple Prices and Their Relation to Marketing Methods. (E. F. Dummeier). The purposes of this study are to indicate economic values of apples in consuming markets based on variety, grade and size and to show changes in market preferences from year to year. Prices realized for the past four years for Washington apples

on the New York and Chicago auctions have been tabulated and classified by varieties, grades and sizes. This material is now being assembled for publication.

Financing Washington Cooperative Organizations. (E. F. Dummeier). The purpose of this study is to indicate how Washington cooperatives are financed as well as the methods of financing that give best results under the different conditions. The study embraces the extent of fixed investment, operating capital requirements, and borrowed money. The financial reports of the various cooperative organizations and other information secured from them are studied. About two-thirds of the basic information is now collected.

The Causative Factors of Success or Failure in the Last Few Years' Growth and Development of Washington Cooperatives. (E. F. Dummeier). The purposes of this study are to bring up to date the information contained in Washington Experiment Station Bulletin 194, published in 1925, and to emphasize further the factors which contribute largely to the success of cooperative marketing. Much of the information required is assembled in connection with the study of financing Washington cooperatives. About two-thirds of the data necessary for the completion of this study are on hand.

Factors Influencing the Effective Location and Functioning of Rural Groups. (F. R. Yoder in cooperation with the Bureau of Agricultural Economics, U. S. Department of Agriculture). This study was continued from last year in order that more information might be gathered from local community units of the Grange, the Farm Bureau, and the Farmers' Union. About three weeks were spent in the field to get the necessary data which are now being worked into manuscript form. This report will be ready for publication early in 1933.

A Study of the Flow of Rural Population and Wealth to Urban Centers and the Flow of Urban Population and Wealth to Rural Areas. (A. A. Smick in cooperation with the Bureau of Agricultural Economics, U. S. Department of Agriculture). The data covering records of mortgages, sales, and leases over a period of years for a representative area in Whitman county, Washington, and a large amount of information from individual farmers concerning population changes as well as movements of wealth between city and country are now being summarized and interpreted. The report should be ready for publication early in 1933.

Land Classification—Pend Oreille County. (Rex E. Willard). At the request of the Board of County Commissioners of Pend Oreille county, Washington, land classification of about 35,000 acres (as a sample area) was undertaken in that county. This involved coopera-

tion with the Soils Section of the Division of Agronomy and with the U. S. Forest Service. Maps were prepared showing soil and land classification, timber cover, ownership, tax delinquency and other conditions. A survey was made of the economic status of farmers in the area.

Timely Economic Information. (Division of Farm Management and Agricultural Economics in cooperation with the economists of the Agricultural Extension Service) This is a monthly economic publication furnished free to residents of the state of Washington which covers the current economic situation including business conditions and information concerning production, consumption and prices of each of the important farm products of the state of Washington. This publication was issued at irregular intervals by the Extension Service but beginning with May, 1932, it has been issued monthly under the cooperative arrangement above indicated. Wherever possible, attempts are made to give an outlook as to the future prospects of production and price trends, in which the material of the Bureau of Agricultural Economics, U. S. Department of Agriculture is of much value

DIVISION OF HOME ECONOMICS

Dean Florence Harrison in Charge

Human Energy Cost of Various Household Tasks. (Miss VeNona W. Swartz). Several representative household tasks have been studied from the point of view of the human energy required for their performance. Eleven women have served as subjects, wearing a portable respiration apparatus.

The work on paring potatoes indicates that this is a light task, requiring approximately 50 per cent more energy than does resting. Sitting in an uncomfortable position on a high stool fails to save energy, while sitting on a chair saves energy over standing for some of the subjects.

Laundry processes are moderately heavy to heavy, requiring an expenditure 100 to 200 per cent above resting. Using a hand wringer cannot be justified on the basis of energy expenditure, for it requires about 60 per cent more energy per load than does wringing clothes by hand.

Ironing napkins is a moderately heavy task, for it requires 50 to 100 per cent more energy than resting. The height of the board does not seem to affect the amount of energy required.

This work is being continued on other household tasks.

Utensils for the Electric Range. (Miss Evelyn H. Roberts). It being impossible to test the efficiency of a utensil except in its relation to actual use, the properties of utensils when used with various surface units or in electric ovens have been the subject of this investigation. Scientific papers, numbers 158, 167, 168, and 176 have been published on certain phases of this work.

The thermal efficiency, speed of heating and heat retention properties of utensils have been obtained by means of a standardized boiling test, involving measurement of the electric power input, the weight of water, that lost by evaporation, time to bring to boil, time maintained at boiling point on retained heat, weight and specific heat of the metal of the pan. Contributing factors as height and diameter of pan, weight of water, condition of sides and bottom, metal of pan, and applied wattage are being studied with relation to the above three properties.

Practical conclusions to date are: (1) there is no justification except on the ground of durability for the use of heavy aluminum ware over light weight ware; (2) the utensil should fit the unit both in base diameter and flatness of base; (3) black bottom ware which readily absorbs the radiant heat afforded by certain units is more efficient than shiny ware on those units; (4) higher wattage units (1200-1300) may be termed speed units but they are not necessarily more efficient units; (5) any pan on a heavily built unit will maintain boiling temperatures for considerable periods, while the same pan on a light weight unit will cool more rapidly; (6) utensils of dark or roughened materials which readily absorb radiant heat are more efficient in electric ovens than shiny ware.

The Vitamin C Content of Washington Apples. (Miss Myra T. Potter, in cooperation with the Division of Horticulture). A study has been completed on the vitamin C content of Winesap apples from the Wenatchee valley. These apples apparently contained about one-tenth of a unit (Sherman standard) of vitamin C per gram. The evidence also indicated that apples grown on a plot which had been treated with a complete fertilizer were somewhat richer in vitamin C than those grown on the unfertilized soil of that region.

The study of the vitamin C content of other varieties of Washington apples will be continued by Miss Esther L. Batchelder.

Vitamin C Content of Winesap Apples as Influenced by Certain Conditions of Fertilization. (Miss Myra T. Potter, in cooperation with the Division of Horticulture). A study has been completed on the vitamin C content of Winesap apples, selected from fertilized and unfertilized trees. Animal feeding experiments were conducted using the technique of Sherman, LaMer, and Campbell. Both skin and pulp were used, this material being ground immediately before feeding to eliminate the effect of

oxidation. Ten grams of Winesap apple fed daily were found to furnish one unit of vitamin C. The fact is significant that at a five gram level, 60 per cent of the animals receiving apples from fertilized trees were protected or developed only mild scurvy, while with animals fed apples from non-fertilized trees, not one was protected, and 80 per cent developed moderate to very severe scurvy. It appears that apples from trees receiving applications of a complete fertilizer (nitrogen, potassium and phosphorus) are a better source of vitamin C than apples from trees not so treated.

Vitamin A Content of Yellow-Tissued and White-Tissued Apples. (Miss Myra E. Potter, in cooperation with the Division of Horticulture). This study was planned to add to general knowledge concerning the correlation between yellow pigment and the presence of vitamin A. Three varieties of apples were selected: the yellow-tissued Golden Delicious and the Starking (Red Delicious), and the white-tissued McIntosh. Animal feeding experiments were made according to the Sherman and Munsell technique. The average weekly weight gain on 1.5 grams of apple was 5.0 gms. for the McIntosh; 4.4 gms. for the Golden Delicious; and 2.4 gms. for the Starking. The Starking was found to require slightly more than 1.5 gms. and the Golden Delicious and McIntosh somewhat less than 1.5 gms. to furnish one unit of vitamin A. Since the McIntosh, a white-tissued apple, is somewhat richer in vitamin A than the yellow-tissued varieties, it would appear that the presence of yellow pigment is not related to vitamin A potency in the varieties studied.

A Study of the Comparative Vitamin A Values of Six Varieties of Frozen Cherries. (Miss Myra T. Potter, in cooperation with the Division of Horticulture). Three types of frozen cherries were used: the Montmorency, the leading sour variety; Bing, Lambert, Deacon and Royal Ann (Napoleon), which are sweet cherries; and the Late Duke, a hybrid. Sound fruit was selected, washed, dried, packed in glass jars, frozen, and held at -10° C. for six to 10 months before the experiment. As required, the fruit was transferred to the ice container of an electric refrigerator, maintained at approximately -7° C. It was weighed while still frozen and fed daily except Sundays. Feeding levels of 0.125 and 0.250 grams furnished insufficient vitamin A. Levels of 0.375 and 0.500 grams showed varying results with the six varieties of cherries, but of the same relative order. Weekly gains or losses for the rat groups fed the 0.375 gram supplements were: Montmorency +7.4; Late Duke +6.2; Royal Ann +4.2; Bing +2.6; Deacon +1.4; and Lambert -1.6 grams. Positive controls gained 13 gms. and negative controls lost 7.7 gms. It is seen that the sour and hybrid varieties offer a richer source of vitamin A than the sweet varieties tested, and of the sweet varieties the Royal Ann ranked highest. In view of the potency of other fruits, cherries may be considered a good source of vitamin A.

DIVISION OF HORTICULTURE

E. L. Overholser in Charge

Winter Injury. (E. L. Overholser and F. L. Overley). Fruit trees with winter injured root systems have a tendency to produce fruit showing a drought spot condition. This condition was less severe in 1932 in orchards where the roots were affected by the winter of 1929-30, probably because of new development of the root system. Average winter soil temperatures 10 inches below the surface of the ground about the root systems of trees with different orchard soil treatments were as follows: (1) loose soil with no cover crop but covered with one to 12 inches of snow, 32.5° F.; (2) loose soil with no cover crop and with the snow removed, 26.5° F.; (3) packed soil having no cover crop, but with the snow covering present, the minimum temperature reached during the season was 34° F.; (4) packed soil having no cover crop, with snow covering removed, a minimum soil temperature of 19° F. was attained; (5) loose soil with straw mulch but with no snow covering, a minimum of 33° F.; (6) loose soil with a good alfalfa cover crop but with no snow covering, a minimum temperature of 27.5° F.

While the hard packed unprotected soil reached the lowest of minimum temperatures of any of the plots studied, it was the quickest to warm up in the spring with the rising air temperatures. On January 23 it was 7½° F. colder than any of the other plots and on February 29 it was 3½° F. warmer than any other plot, with a temperature of 39° F.

Development of Methods of Propagating Hardy Apple Stock. (O. M. Morris and L. L. Claypool). Hardwood cuttings were made of several varieties of apples at regular intervals from September 20 to March 1. These were stored at various temperatures from 45° to 65° F. and nearly all produced good callouses but no roots. The cuttings stored at temperatures approximately 55° F. developed the largest callouses. Cuttings were dipped in melted paraffin down to within two inches of the base and stored as those above with no visible differences in the effect on their callous and root development.

Young apple trees were laid down in position of layers and new growth covered with moist earth. No roots had developed on this material by June 30. This work is being continued through the season.

Orchard Cover Crops. (O. M. Morris and F. L. Overley). Plots of ground in an orchard near Wenatchee were planted to sweet clover, common red clover, and alfalfa, early in April. These each produced a medium to good stand of plants in early spring. By the last of June nearly all the plants were dead. The few remaining were usually found

along the edge of the irrigation ditches. The death of the plants was, in most cases, due to lack of water caused by the long time between irrigations.

Fine fibrous roots of apple trees were found in abundance and densely branched in the first foot of soil under the mulch developed by an alfalfa cover crop. Less than one-half as many roots were found in the first foot of soil of clean tilled plots, and under blue grass sod and dense weed growth there was less than one-fourth as many fine fibrous roots as found in the first foot of soil under the alfalfa mulch.

It has been the experience that permanent cover crops may favor tarnished plant bug and tree hopper injuries to the orchard trees. Some species of red spider are found on certain cover crops as well as on the orchard trees.

Orchard Fertilizer Investigations. (E. L. Overholser and F. L. Overley in cooperation with the Soils Section of the Division of Agronomy). The nitrogen fertilizer application should vary with different varieties of apples under similar conditions. Jonathan and Rome apparently respond more quickly to heavy application of nitrogen fertilizer than do Delicious and Winesap. Leaf area studies indicate that both varieties produce a normal size apple for the variety with less leaves than either Winesap or Delicious. With an excess leaf area both Jonathan and Rome tend to show internal breakdown while Winesap or Delicious are not affected in the same way. Large fruit is more subject to Jonathan breakdown than is smaller size fruit. Thus, insofar as fertilizer applications may increase the size of fruit, and may give a relatively large leaf area per fruit borne, the susceptibility to Jonathan breakdown may be increased.

When either phosphate or potash is used alone, on soils lacking in nitrogen, the June drop has been consistently greater, even with a lesser fruit set, than that on unfertilized plots. Nitrogen alone or in combination has favored an increased set of fruit in comparison with unfertilized plots and plots to which potash or phosphate alone have been applied. Where nitrogen is not a limiting factor, however, the application of phosphate and potash together without further nitrogen has equaled the set of combinations including nitrogen. The combination of nitrogen and phosphate has given as large a set as any other fertilizer application.

Where nitrogen has been a limiting factor the addition of nitrogen either alone or in combination with phosphate or potash fertilizers has resulted in increased yields. The other element, which with certain soils has benefited yield, is phosphorus when applied in combination with nitrogen.

Nitrogen alone or in combination tends to maintain size of fruit notwithstanding an increased tree load as compared with the unfertilized plot. As compared with fertilization with either phosphate or potash alone, however, nitrogen either alone or in combination tends to increase the average size of individual fruits.

Nitrogen either alone or in combination with phosphorus and potassium opposes maximum color development on trees that are not undernourished primarily by: first, delaying maturity attainment of the crop, and second, by giving more shade from increased leaf development. Under some conditions, larger size of fruit and increased total tree yield may offset possible lowered returns from lessened color development.

Tree circumference, terminal growth (diameter and length), size and color of individual leaves are benefited by the application of nitrogen where this element is a limiting factor.

Some Effects of Fertilizers Upon Storage Responses of Apples. (F. L. Overley and E. L. Overholser). Data obtained inclusive of the 1931 season concerning the storage response of apples have been published as Scientific Paper 212.

With fruits of the same size and color any one season, there have been no significant differences in firmness of texture of Jonathan apples at harvest time or after three months' storage at 32° F., as a result of fertilizer treatments. At harvest, there has been little difference in the firmness of fruit from season to season between apples comparable in size and color. After three months' storage at 32° F, however, all lots varied from season to season. Hence, with uniform samples of comparable size, color and maturity, other environmental conditions exerted greater influence upon firmness of flesh than did the fertilizer treatment. The fertilizer application, however, may affect the size, degree and per cent of red color, and the time of maturity. Hence, to this extent the firmness of the fruit of representative samples from the different fertilizer plots may be affected in conformity with these preceding factors.

Effect of Oil Sprays on Apple Trees. (F. L. Overley and E. L. Overholser in cooperation with the Divisions of Entomology and Chemistry). Thirty different plots were sprayed with various oil sprays and lime sulfur, in dormant, pink, and calyx and first and second covers. The results were somewhat different than those obtained in previous years. No injury to buds, or set or drop of fruit, was noted in any plots when lime sulfur in dormant, pink or calyx was followed by oil in first or second cover during 1932.

Some bud injury was noted in plots where tank mix and especially quick breaking oils were used as a dormant spray. The fruit bud kill

varied from 1.9 per cent to 6.5 per cent with almost no reduction in set of fruit per tree on Jonathans, although in many instances the leaf and spur buds were delayed in starting and many trees showed a rosette appearance for several weeks after leaf growth started. Similar sprays on Winesap and Delicious caused more injury than on Jonathan trees. With some trees sprayed with tank mix type of spray, the leaf and spur vegetative buds and as high as 10.8 per cent of the fruit buds were killed. The fruit set was reduced from 18.5 to 31.4 per cent as shown on the check trees, to as low as 10.6 per cent on the oil sprayed trees.

Arsenical Residue on Apples. (F. L. Overley in cooperation with the Engineering Experiment Station and the Divisions of Agricultural Engineering and Entomology). With the cooperation of the Wenatchee Valley Traffic Association, a washer was designed and constructed for experimental purposes. The washer includes some relatively new features and principles, including both under brushes and over brushes. It was especially designed for use of alkali wash solutions. Over 65 different combination tests have been made with different forms of treatment and different solvents with something over 500 samples of fruit, representative of the several different spray schedules used in the district for codling moth control. These spray schedules include various combinations of fish oils, mineral oils with leads, dutox, lime and various other spreaders.

Fruits most difficult to clean with as high as 155 grains AS_2O_3 per pound, have been successfully cleaned well below the tolerance, 01 grains AS_2O_3 per pound. A new cleaning solution in the residue removal, sodium silicate Na_2SiO_3 , is being tested. This solution has been satisfactory in all tests, especially with brush machines.

Peach Harvesting and Storage. (O. M. Morris) Studies on the harvesting of peaches have been published as Washington Experiment Station Bulletin 266. Peaches harvested while hard and not beginning to soften along the suture line and around the stem end, were uniformly of low quality when ripened. Only those fruits left on the tree until softening began were good or best in quality. Fruits sufficiently matured to be bruised in common commercial handling were uniformly of better quality than those that did not show bruises. J. H. Hale, Elberta, and similar varieties left on the tree until sufficiently mature to be of good quality were, by using more care in handling, harvested, packed, and shipped to market with almost no bruising.

Peaches stored at 32° F. did not ripen, but changed to shades of yellow or brown color and softened but were not fit for food. Mature fruit held at 32° F. in storage for five to eight days and then at 60° to 65° ripened and was of good quality.

Sweet Cherry Pollination. (E. L. Overholser and F. L. Overley). Data on the pollination of sweet cherries obtained during 1931 have been published as Scientific Paper 208. The 1932 data largely substantiated the results obtained during the two preceding years. The Deacon continued to be an excellent pollinizer for the Bing, Lambert, and Napoleon. While the Deacon usually tends to be self-sterile, it was partially self-fertile in 1932. While the data of 1930 indicated the Bing, Lambert, and Napoleon were each satisfactory pollinizers of the Deacon, the data in 1931 raised a question of doubt. The 1932 data substantiated the 1930 data, and indicated the Bing was the best of the three as a pollinizer of the Deacon. In addition, the Black Republican was also satisfactory as a pollinizer for the Deacon.

Apple Bud Sports Pollination. (E. L. Overholser, F. L. Overley and K. A. McKenzie). Data on the pollination of apples obtained during 1931 have been published as Scientific Paper 204. Data obtained during 1932 largely substantiate the findings in 1931. Golden Delicious was a satisfactory pollinizer for Delicious and Starking although it again was inadequate as a pollinizer for Richared. The McIntosh was a good pollinizer for the Winesap, Delicious and Starking. The King Jon again gave only a fair set when used as a pollinizer for Richared. The Yellow Newtown was a very good pollinizer for the Richared, Starking and Delicious.

Little Leaf of Fruit Trees. (E. L. Overholser, L. L. Claypool and F. L. Overley). The results of a 1931 survey of little leaf (rosette) of fruit trees in central Washington have been published as Scientific Paper 219. Little leaf was observed mainly with apples, peaches, and cherries in orchards having no permanent alfalfa cover crop or where corrals for livestock had previously existed. A number of orchards where the practice of growing a permanent alfalfa cover crop had been discontinued showed severe little leaf. These orchards had not been affected when they were in cover crop. In no case was little leaf found in orchards having had a good uniform stand of alfalfa during the preceding three years. Where conditions prevent the maintenance of a good stand of alfalfa, this season's work, employing findings of Chandler in California, indicate that zinc sulphate injected into holes about the base of the trunk in the late winter brings about marked recovery by midsummer.

Red Raspberry Breeding. (C. D. Schwartze). Progress thus far includes the production of 4855 seedlings by crossing and inbreeding seven varieties. In 1932, three additional varieties were used with the production of approximately 17,000 seeds. Future plans include the testing of canes in the laboratory to determine their comparative hardiness, and, if possible, the mode of inheritance of hardiness. As

300 of the seedlings bore fruit for the first time this year, these were observed in the field. One selection was made for further testing as a possible commercial variety.

Strawberry Breeding. (C. D. Schwartz). Prior to 1932, 175 varieties and seedlings were grown in test plots and their characteristics recorded. Thirty-two of these were used as parents in producing 5,024 seedlings by hybridizing and inbreeding. Progress in 1932 consisted of obtaining and recording data from these seedlings relative to the inheritance of color, firmness of flesh and yielding ability. This phase of the work must be continued for at least two more years before conclusions can be drawn as to the inheritance of characters. One hundred and nine of the seedlings were selected in 1932 for further observation because of qualities which may be of value commercially. The prospects for developing a new variety for western Washington are encouraging.

Potato Breeding. (C. L. Vincent). All numbered seedlings dug in 1931 were stored and replanted in late May, 1932. Every fifth row throughout the field was planted to diseased potatoes to encourage the spread of virus diseases. A careful record was made of the disease condition. Those infected with mosaic or other degenerate diseases were dug and discarded at the close of the season. A few very promising seedlings, from the standpoint of virus disease resistance, have been selected. An attempt will be made to eliminate spindle tuber and other diseases from these virus resistant seedlings so they may be distributed to interested growers in the fall of 1933. In addition to the numbered seedlings, several thousand first year seedlings from crossed and open pollinated parentage were planted. These were likewise planted with diseased potatoes to enable them to become infected with virus diseases.

The summer of 1932 was unusually cool and a large crop of seedballs resulted from the crosses made. Katahdin was an unusually heavy producer of seedballs. It was equally good as a male and female parent. A few local seedlings also gave as fine fruit set as both parents. Netted Gem, Washington's leading late potato, will not set fertile seedballs under any conditions. The pistils are imperfect and the pollen sterile.

Potato Storage. (C. L. Vincent and E. I. Overholser). Netted Gem potatoes of known weight were again stored at temperatures of 40° F. and 32° F. under well aerated and inadequately aerated conditions to determine the effect of temperature and aeration upon sugar accumulation. Those stored at 32° F. shrunk 3 per cent during the period and those stored at 40° F. lost 4 per cent of their weight. Both lots of potatoes were firm and unsprouted on April 25 when the weights were taken. The humidity of the storage rooms was 85 to 90

per cent at 32° F., and 72 to 78 per cent at 40° F. At both low temperatures, when there was inadequate aeration, sugars increased over potatoes stored at the same temperatures with good aeration. The greatest sugar increase occurred in potatoes stored in an atmosphere having a high carbon dioxide content and at the higher temperature.

Tomato Breeding. (C. L. Vincent). Tomato seedlings produced from crosses between Bonny Best and Best-of-All, a Sutton selection, were again grown in the college greenhouse as a spring crop. Seedlings Nos. 6, 16, 38, and 50 continued promising. Pressure tests, using a strawberry tester, with skins on and off were made of all varieties at each picking to determine shipping qualities. It was thought that the tomato having the firmer skin and flesh probably would be a better shipper. Likewise respiration studies were run on five of the most promising seedlings. The problem will be continued in 1933.

DIVISION OF PLANT PATHOLOGY

F. D. Heald in Charge

Wheat Smut. (F. D. Heald in cooperation with the Division of Agronomy by E. F. Gaines, and the Office of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture by C. S. Holton). Special emphasis has been placed on a study of the physiologic strains of *Tilletia tritici* and *T. levis*, with the result that 10 of the former and 12 of the latter have been identified. Tests have been made of the behavior of physiologic strains in periodic plantings, some differences of performance being revealed.

Studies also have been made on the effect of rate of seeding on the per cent of bunt, a comparison of drill or surface and trench seeding, and the influence of moisture and time of seeding on the effectiveness of seed treatment, especially the copper carbonate dust treatment.

Apple Rots. (F. D. Heald, Kenneth Baker and Glenn A. Huber) The work on rots of apples in cold storage has been continued with principal attention to three phases of the problem: (1) lenticel infection by blue mold; (2) the effect of commercial cleaning solutions on the viability of blue mold spores; and (3) further studies on the sources of the spores of apple-decay fungi. Lenticel infection has been shown to be the cause of a high percentage of blue mold decay in storage. The results have been published in a technical paper, Washington Experiment Station Bulletin 264. Contrary to published reports by other workers it has been found that blue mold spores are killed by the solutions used for the removal of spray residue. The maximum spore load of the treating solution is reached after a few hours' run

The detailed results of this work appear in *Phytopathology* **22:879-898**. The study of sources of contamination has emphasized sanitation as of extreme importance in reducing losses from blue mold.

Fusarium Wilt of Peas. (L. K. Jones and K. J. Kadow). Investigations have been continued during the past year on the *Fusarium* Wilt disease of peas with special reference to its dissemination. The results have been published as bulletin 272 of this station. It is concluded that the disease is seed-borne. The disease is disseminated in the field by agricultural instruments, especially the combine harvester, by wind and by water. Negative results were obtained in tests to determine the possible passage of the organism through the alimentary tracts of birds and animals. The use of resistant varieties is recommended in order to reduce losses from this disease.

Cooperation with the Office of Horticultural Crops and Diseases of the U. S. Department of Agriculture in the development of resistant varieties is being continued.

Virus Diseases of Raspberries. (L. K. Jones). The rate of spread in western Washington of red raspberry mosaic has been determined in an experimental planting at Puyallup, Washington. It has been shown that in the Cuthbert variety the disease will spread once it has been introduced, to increase the amount of diseased plants about 20 per cent each year. This is similar to the rate of increase reported in New York state. The rate of spread from red raspberries to black raspberries is considerably more rapid. There was an increase from five per cent to 80 per cent diseased plants in one year in the Cumberland variety planted adjacent to red raspberries.

Investigations have been started to determine the practical value of roguing out diseased plants from plantings where the disease is becoming established. In one planting of about 7,500 plants of the Marlboro variety, 2.8 per cent of the plants have been rogued out due to disease. Observations will be continued to determine the effectiveness of this procedure.

A survey of the raspberry plantings in western Washington showed that true mosaic of red raspberries was present in plantings in Thurston, Pierce, King, and Snohomish counties. Visits to 16 red raspberry plantings near Puyallup revealed the fact that eight of the plantings were free from true mosaic. Eight plantings showed from two to 30 per cent of the plants affected with this disease.

Virus Diseases of Potatoes. (L. K. Jones, Grover Burnett and E. J. Anderson). During the past season 17 potato growers in the state sent a total of 761 tubers for indexing to determine their freedom from virus diseases. Thirteen per cent of the tubers were affected with

damaging virus diseases. The apparently healthy tubers were returned to the growers for seed-production purposes. Detailed tests of these apparently healthy tubers showed that they were all affected with a latent type of virus. These results are similar to those reported previously and show that practically all commercial potatoes grown in the state are affected with a virus disease. Strains of potatoes are being developed from true seed that are free from all virus diseases.

Further investigations on the latent and veinbanding viruses of potato have shown that these viruses are capable of retaining their virulence in dried plant tissue much longer than has been indicated by previous investigators. The veinbanding virus is inactivated by drying, more readily, than the latent virus. The latent virus when combined with tobacco mosaic in tomato plants retains its virulence much longer (one year or more) than when dried as a single virus.

Washington Experiment Station Bulletin 259 has been published dealing with the effect of certain potato and tobacco viruses on tomato plants.

Verticillium Wilt of Chrysanthemum. (L. K. Jones and Glenn A. Huber). Verticillium Wilt is prevalent in greenhouses in the state and 100 per cent damage to the crop has been noted with certain varieties. Tests are being made to determine susceptibility or resistance of the more common varieties to this disease. Preliminary investigations tend to show that the organism is carried in the cuttings taken from diseased plants. Control recommendations should emphasize the use of cuttings from healthy plants as well as soil sterilization.

Downy Mildew of Pea. (L. K. Jones and F. D. Heald) The severity of this disease in a number of west side localities has been brought to light by the Plant Disease Survey, preliminary studies have been made and work is being continued. Pod infection is the serious aspect of the disease and has been responsible for as high as 60 per cent culls in certain pickings. The overwintering stage (oospores) has been found in the seed from pods showing mildew lesions. Since infected seed may carry the trouble, the crop from infected fields should not be used for seed. The downy mildew is of principal importance in the regions producing a late fall crop.

The Plant Disease Survey. (F. D. Heald and L. K. Jones in cooperation with the Plant Disease Survey of the U. S. Department of Agriculture). In addition to the usual reports from correspondents which have furnished much information, additional data have been obtained during several trips primarily for the study of alfalfa, pea and bramble diseases. Only those diseases which are either new to the state or present new or noteworthy phases will be mentioned.

The following have not been previously reported from the state: cane canker of roses caused by *Coniothyrium wernsdorffiae* was serious on rambler roses in Manito Park, Spokane; rose bloom of azaleas caused by *Exobasidium azaleae* was reported from Winslow; scab or red thorn, *Pyraecantha coccinea*, caused by *Venturia crataegi* was obtained from two west side localities; leaf spot of peony, caused by *Septoria paconiae*, from Puyallup; and the blight of chestnut caused by *Endothia parasitica* from Seattle. Observations have been made on a chlorosis or variegation of Jonathan apple leaves in the Yakima district, the cause of which is being studied.

The following observations on troubles previously reported are of interest: The disease of mangels and sugar beets known as late blight has been observed in both east side and west side localities both with and without the accompanying heart rot caused by *Phoma betae*. Apple scab has appeared again in eastern Washington (Spokane Valley) after many years' absence. Powdery mildew of the grape caused by *Uncinula necator* has appeared again at Walla Walla and Kennewick after practically disappearing for a number of years. The following diseases were very destructive in western Washington: powdery mildew, *Erysiphe polygoni*, downy mildew, *Peronospora viciae* (pisi), and mosaic of peas; leaf curl *Taphrina deformans* of peach; scab, *Venturia inaequalis* and powdery mildew, *Podosphaera leucotricha* of apple; bacterial canker, *Phytophthora michiganense*, wilt, *Verticillium albo-atrum* and curly top of tomato.

Complaints concerning the deterioration of alfalfa fields have come from the Walla Walla area and from Kennewick to Yakima. Limited observations have indicated that no single factor is responsible for the decline in yields. Fungous and bacterial infections, stem nematode, little understood virus troubles and poorly adapted varieties susceptible to winter killing appear to be playing a part. The seriousness of the losses would justify a detailed study of the problem.

DIVISION OF POULTRY HUSBANDRY

J. S. Carver in Charge

Breeding and Selection. (J. S. Carver). This study of the relation of inbreeding to egg production is being continued with Rhode Island Reds and White Leghorns.

Protein Requirements of Laying Hens. (J. S. Carver and D. Brazie in cooperation with the Division of Chemistry). Protein balance experiments are being conducted with nine lots of hens housed

in nutritional batteries. Several protein levels of herring fish meal are being compared.

Protein Requirements of Growing Chicks. (J. S. Carver and D. Brazie in cooperation with the Division of Chemistry). Three lots of chicks were grown on three different levels of herring fish meal protein for a period of 10 weeks. The three protein levels used were 12, 16, and 20 per cent. The protein intake and the protein elimination were measured for each lot. At the age of 10 weeks each of the three lots of the protein levels of 12, 16, and 20 per cent were divided into three separate lots and fed on protein levels of 12, 16, and 20 per cent herring fish meal. The efficiency of growth on each of the several levels of low, medium, and high protein will be determined.

The Biological Values of Proteins. (D. Brazie in cooperation with the Division of Chemistry). This study was undertaken to determine the biological values of various protein concentrates and blends of these protein concentrates used in commercial chick and laying rations in this state. The protein concentrates that will be studied are two different types of meat scraps, two fish meals, and skimmilk powder, and blends of these several protein concentrates. The biological values of each concentrate and blend will be computed at the conclusion of the eight weeks' growing period.

Sardine Oil as a Source of Vitamin D for Growing Chicks. (J. S. Carver in cooperation with the Division of Chemistry). Biological tests were conducted to determine the vitamin D potency of sardine oil when used at different levels with the W. S. C. chick ration with various mineral levels. The chicks on each mineral level were fed levels of $\frac{1}{8}$ per cent sardine oil, $\frac{1}{4}$ per cent sardine oil, and $\frac{1}{2}$ per cent sardine oil added to the all-mash ration. Lots 1 to 4 inclusive had no mineral added to the basal ration. Lots 5 to 8 had $1\frac{1}{2}$ per cent bone meal and $1\frac{1}{2}$ per cent oyster shell flour added to the basal ration. Lots 9 to 12 had 1 per cent oyster shell flour added to the basal ration. Lots 13 to 16 had .10 per cent oyster shell flour and 3.39 per cent bone meal added to the basal ration.

The Vitamin D Requirements of Growing Chicks and Laying Hens. (J. S. Carver, D. Brazie and E. I. Robertson in cooperation with the Division of Chemistry). This experiment involves 11 lots, each lot containing 200 White Leghorn chicks, and was started April 2, 1932. All these lots were fed on the same standard all-mash ration. Lots 1 to 6 inclusive were kept in confinement, with no exposure to sunlight and fed a biologically tested concentrated vitamin D supplement at levels of 0, $\frac{1}{32}$, $\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{4}$, and $\frac{1}{2}$ per cent of the total ration. Lots 7 to 11 inclusive received the same treatment with access to wire screened sun porches throughout the day and received vitamin

D supplement at levels of 0, 1/32, 1/16, 1/8, and 1/4, respectively. All of the cockerels were removed at four weeks and data gathered on pullets only, from then on.

At 24 weeks of age the number of birds in each pen was reduced, by careful selection, to 44.

From the end of the 24th week on, data are being collected on trapnest egg records, bird weight and physical condition, feed consumption, and mortality by four-week periods. Individual egg studies are being made one day each week as to egg weight, volume, shell texture as seen under the candle, interior quality as seen under the candle and also after the egg is broken, air dry weight of shell, and oven dry weight of shell.

At representative periods hatchability tests will be made on the eggs from all pens.

ADAMS BRANCH EXPERIMENT STATION

H. M. Wanser in Charge

General Conditions. Conditions were slightly more favorable for crop production in 1932 than for the years immediately preceding. For three years the precipitation had been below average but for the crop year September 1, 1931 to August 31, 1932, it was 24 per cent above average or 9.78 inches. It was poorly distributed, however, and only average yields resulted. The fall was too dry for favorable seeding and very little winter wheat was sown. The winter absorption period had 47 per cent more precipitation than average or 7.35 inches. The snow and rain falling on frozen ground amounted to 4.22 inches and much of this was lost as runoff in the spring thaws. Moisture equivalent to 4.25 inches precipitation was held in the soil of the fields to be cropped at the opening of the spring growing season. Rainfall was deficient during the growing season, especially for the month of June and crop growth was curtailed.

High winds were frequent all spring and soil erosion by wind was a serious problem on many fields. Deposits on the station farm from a neighbor's field caused considerable worry for a time but were controlled.

Varietal and Selection Experiments with Cereals. (H. M. Wanser and H. D. Jacquot) The varietal experiments in 1932 included sowings in replicated plats of 29 varieties of winter wheat, 46 varieties of spring wheat, four varieties each of winter rye and spring barley, three oats and two spring ryes. Ten selections of Baart hybrids also were

grown in plats. One hundred twenty-six varieties and selections mostly of spring wheat were grown in eight rod rows which were sown with a field drill. The hand drilled cereal rod row varietal nursery included 40 varieties of winter wheat and three ryes, and 23 varieties and 60 selections of spring wheat. About 60 varieties also were grown in a cooperative nursery at Wilbur.

Fall seeding conditions were so dry that germination of fall sown grain was delayed until early spring and resulting stands were thin. The spring growing season started quite favorably but deficient rainfall and replenishment of soil moisture supplies closed it rather unfavorably and the quality of all cereals was poor.

The yields of the four varieties of winter rye for 1932 were almost identical with their 12 year average or nearly normal. Dakold had the highest average yield which was 108 bushels per acre. The grain yield of winter wheat in adjacent plats was two per cent less whereas it generally is about 30 per cent more. Three varieties introduced from U. S. S. R. had not yet produced sufficient seed to be included in the plat trials.

Winter wheat varieties of the Crimean or Turkey type have shown greater promise than varieties of other types and 14 of the 29 varieties of winter wheat grown in field plats were of this type. Kharkov was the leading variety and had a yield of 10.9 bushels per acre. Five other Crimean varieties were among the six highest yielding varieties. None of the new varieties added had yields equal to those of the standard varieties.

In the cooperative rod row cereal nursery grown both at Lind and north of Wilbur the Crimean varieties again were best at Lind but poorest at Wilbur. At Lind the only varieties surviving the winter and producing a stand worth harvesting in the row nursery were of the Turkey type but at Wilbur all varieties emerged under the snow. Triplet had a yield of 39.9 bushels per acre which was the highest. The results of two years' trials suggest that less hardy varieties than the Crimean will withstand the winters and produce better in the area north of Wilbur.

In the plat trials with spring wheat the average yield from quadruplicate plats was 12.3 bushels for Baart which was three per cent better than for any other variety. The 37 other varieties in the trial all had yields within small variations and an extreme range of 19 per cent.

In the cooperative rod row trials with spring wheats sown both at Lind and at Wilbur again Onas, Federation and other varieties of the Federation type were the best varieties at Wilbur. At Lind, Baart was slightly better than the varieties of Federation type. The yield of Onas at Wilbur was 45.3 bushels per acre. The average yield of the

spring nursery at Wilbur was 37 bushels compared with 30.5 bushels for the winter wheat nursery.

Further selecting of hybrid material and testing of selections previously made for improving the smut resistance and upstanding plant characteristics of Baart spring wheat was continued. Nearly all selections have been awned plants as a comparison shows the yields of awned progeny exceeds that of the awnless by from eight to 16 per cent. About 30 per cent of the 59 selections from Baart x Ridit which have been retained showed a high degree of smut resistance but less than 10 per cent of them had yields and quality equal to the Baart parent. Nearly all selections with Ridit parentage droop or lodge slightly. Smut resistance without sacrifice in other qualities is not yet assured. In the 40 selections from Baart x Onas all had more upstanding characteristics than Baart and about 40 per cent had yields equal to Baart but in only two of them was the quality of the grain equal to Baart. Dwarf plants appear in the Baart x Onas hybrids and some of them have been selected. Grain production was normal although only the terminal internodes of the culms of the dwarf plants elongated.

The 56 rows grown for determining the causes of red mixtures in Baart showed that field hybridization with red wheats had taken place and in some lots the proportion of red kernels was increasing but in most of the lots there was no increase in red kernels. Some of the lots consistently yield more than others and suggest the probability of further improving the yield of Baart by selection.

In the cooperative smut nursery eight varieties of winter wheat, four of which had Ridit parentage, showed no infection.

Flynn was the best variety of barley and Markton, the best variety of oats. The grain yields of barley and oats were 79 and 78 per cent of the grain yield of spring wheat.

Cultural Experiments with Cereals. (H. M. Wanser and H. D. Jacquot). When spring opened in 1932 the seedlings of winter wheat were just emerging through a crusting soil. Cultivation at such stages generally has proven detrimental but this year harrowing during March increased the yield from 6.5 bushels to 8.7 bushels per acre.

A lister type deep furrow drill was loaned the station by the Dempster Manufacturing Company. Sowings of spring wheat made with the drill were too deep and so delayed emergence that the yield was decreased about nine per cent.

Tillage and Soil Moisture Problems. (H. M. Wanser and H. D. Jacquot). The project with 21 variations in schemes of tillage for the preparation of summer fallow was continued. The series of plats in fallow during 1932 absorbed five and one-half inches out of 6.88 inches

of precipitation received during the winter absorption period. The plats having a mulch created in moist soil on them were favored in the absorption of the unusually heavy winter precipitation. Most of the moisture advantage had disappeared, however, by the end of the fallow season, at which time both wet fall plowed and early spring plowed surfaces had conserved nearly equal amounts of moisture (3.27 and 3.16 inches). Other treatments conserved lesser amounts. This is the first fallow season for several years with sufficient soil moisture for variations in tillage to show sizeable variations in moisture conservation.

The series of plats in crop during 1932 closed the fallow season of 1931 with conserved moisture supplies of less than one-half inch. During the absorption period of the second winter (1931-1932) they absorbed more than eight times the conserved supplies. This condition tended to smooth out other variations. However, because a deep mulch tended to favor absorption the second winter those treatments having a deeper mulch at end of fallow season were better than comparable treatments having a shallower mulch.

Runoff measurements were made on the drainage basin which includes the station farm. There were 4.22 inches of precipitation on the frozen soil of this basin between November 21 and February 23. Thawing weather caused runoff on 23 days between January 9 and February 26. The maximum flow from the 888 acres in the basin was 38 second feet. The upper four-fifths of the basin above the station is gently rolling land. It lost 12 per cent of the winter precipitation as runoff. The 185 acres on the station is much rougher land and it lost 37 per cent as runoff.

Runoff measurements were also made on adjacent plowed and stubble areas which had a slope of 10 per cent. The plowed area lost 12 per cent of the precipitation which fell on frozen soil and the stubble area lost 44 per cent. The maximum flow on the plowed area was .029 second feet per acre and on the stubble area, .135 second feet. These data suggest fall plowing to be a good practice for conserving runoff waters from heavy snowfall. Average yield data however have shown that fall plowing for summer fallow preparation is not the best farm practice.

The measurement of the runoff waters required so much attention this year that measurement of the silt carried by the waters could not be made.

Through the cooperation of the Soil Erosion Station at Pullman four areas were cultivated with the hole digging cultivator developed at the Erosion Station at Hays, Kansas. Observation after each of the four melt-off periods of the winter showed the surface soil of these areas appeared wetter and remained moist longer than the soil of

adjacent nontreated areas. Moisture determinations in the spring showed that on nearly level areas the hole digging cultivator had increased absorption of the winter precipitation by one inch of moisture. On the areas which were later fallowed the increase still amounted to six-tenths inch by the end of the fallow season. On the areas which were sown to spring wheat the average yield was increased by seven-tenths bushel per acre.

Permanent Fertility and Organic Matter Maintenance. (H. M. Wanser and H. D. Jacquot). The organic matter maintenance series of plats have been conducted for 10 years and five applications of residues have been made. The plats on which residues with nitrogen were applied showed increased nitrification and yield in 1932. Excess applications of high carbon residues did not depress nitrification as at the start of the experiment. Laboratory determinations on the surface soil show that five applications of residues over a period of 10 years have had too small an influence on the nitrogen and carbon content to be measurable. Any change in permanent fertility that has been effected could not be measured by laboratory determination.

In another series of plats ammonium sulfate did not affect the yield on continuous crop plats.

Forage and Miscellaneous Projects. (H. M. Wanser and H. D. Jacquot). Several plats of perennial grasses were added to the forage nursery in 1932. Plats of Quincy grass (*Oryzopsis hymenoides*) which has received popular recommendation for abandoned sandy lands was included. Seed treated to increase germination and untreated seed were sown. The best stands were obtained from untreated seed but factors controlling germination were not understood as attempts to germinate seed under partially controlled conditions were failures.

Crested wheat grass has been established on nine acres of pasture and the best half was harvested for seed. The yield was 100 pounds per acre of fair quality seed. About three times that much forage was harvested and it appeared the unharvestable basal leaf forage about equaled that harvested.

To increase the forage plantings, seed of perennial rye and a number of native grasses was gathered. A number of selections of crested wheat grass and slender wheat grass also were made.

Service features included the distribution of the entire crop of Baart spring wheat as clean seed. A few Chinese Elm shade trees were also distributed. A special Visitors' Day was held with the aid of the local county agent. More farmers attended than last year and the features and projects of the station were explained.

A small thresher was constructed by the assistant staff member and an account of it appears in the Journal of American Society of Agronomy, April, 1932.

IRRIGATION BRANCH EXPERIMENT STATION

H. P. Singleton in Charge

General Conditions. Owing to the large amount of snow in the mountains during the winter months of 1931-32 the water storage reservoirs of the Reclamation Service were filled by the first of June. It was unnecessary to use any of the storage water before that time as the natural flow of the streams was sufficient to supply the canals. Water was delivered to the experiment station April 12, which is about two weeks later than it is normally diverted to the station and three weeks later than last year. The tardiness in diverting the water was due to construction work on the Prosser siphon. The experiment station has an allowance of three acre feet per acre for the season and this season 2.9 acre feet of water were delivered. This is the best supply of water received in the last three years.

Rainfall at the station from October 1, 1931 to October 1, 1932 was 7.8 inches. Most of this fell in the form of snow during the winter. The minimum temperature for this period was -3° F. and the maximum was 100 degrees. The average wind velocity amounted to 2.72 miles per hour, and the evaporation from a free-water surface amounted to 35.328 inches during the period from April 1, 1932 to October 1, 1932. The frost-free period this season was 153 days.

Forage Crops. (H. P. Singleton). Alfalfa is the most important irrigated forage crop in Washington. Varietal investigations have been conducted for 12 years. Good strains of Northern Grown Common have outyielded the winter-hard strains including Grimm, Canadian Variegated, and Baltic by more than one-half ton per acre per year. Still more significant is the fact that during the entire time the Northern Common strains have outyielded the winter-hardy varieties every year notwithstanding the severe winters that have occurred during this time. Ladak, a rather new variety, has been grown for five years. It has given high yields on the first cutting, fair on the second, but very poor on the third, making its average yield considerably below that of Northern Common.

Pasture investigations were continued on the acre plots with results comparable to those of former years, the Biennial White sweet clover having the highest carrying capacity with Ladino clover and mixed grasses next in order.

The most important phase of pasture investigations this year was the continuation of the sweet clover nursery. The results from two years indicate that there is a possibility of securing varieties far superior to those now in use. This work will be continued and enlarged next year.

Cereals and Corn. (H. P. Singleton). The cooperative cereal work with the Office of Cereal Crops and Diseases, U. S. Department of Agriculture, was continued. In addition, a number of smut-resistant wheat hybrids were grown in the cereal nursery. Spring wheat still leads other cereals in yield of grain per acre, Jenkin being the high ranking variety. Some of the new hybrids are showing promise and may become of commercial importance.

Corn is the highest yielding grain crop grown in the Yakima valley. This was a good corn year with yields of over 100 bushels per acre at three locations in the Yakima valley, namely, at the experiment station, at a cooperator's farm north of Outlook, and at a cooperator's farm west of Satus. Cooperative trials with corn were conducted at various locations extending from Benton City to Toppenish with most of the important corn growing districts being represented. Good local strains of Yellow Dent, Reid Yellow from Iowa, and Iodent, also from Iowa, were the high yielding varieties. Thayer Yellow, a small early maturing variety, yielded over 73 bushels per acre at five locations in the Yakima Valley. All yields are on the basis of No. 1 shelled corn containing not more than 12 per cent moisture.

Soils. (H. P. Singleton). (a) Fertilizers in a Three-Year Rotation of Potatoes, Corn and Wheat. Part of these investigations were started in 1922. Both organic fertilizers containing nitrogen have been beneficial. Straw applied alone depressed the yield at the beginning of the experiment but the yield of this plot has gradually increased so that it was slightly larger than on the check plot during the last two years. Phosphorus or potash applied alone have produced very little response. The plot series was extended in 1930 to include nitrogen, phosphorus and potash in various combinations. All plots were in corn this year.

Yield differences on the original plot series have been as much as 340 per cent of the check plot yield. Higher yields have been secured from organic fertilizers including sheep manure, horse manure, fish meal, and alfalfa hay, than from inorganic nitrogen fertilizers.

(b) Fertilizers for Alfalfa: An alfalfa fertilizer experiment was started in 1931. Fertilizers were applied before plowing for the alfalfa seed bed. Various combinations of nitrogen, phosphorus, potash, calcium and sulphur were used. An excellent stand of alfalfa was obtained on all plots. No yield data were secured in 1931. The second application of fertilizers was made in the early spring of 1932 just before the plants started growth.

Although there was considerable variation in the yields of the check plots throughout the series, it appeared that phosphorus was of some benefit to the crop. Nitrogen, calcium, potash or sulfur did not cause any measurable increase in yield.

This experiment will be continued.

Livestock. (H. P. Singleton). Aside from the livestock owned by the station, about 2000 lambs were fed on contract during the winter of 1931-32. Eighteen lots of 25 lambs were fed experimentally. All lots were fed without shelter. Three general problems were studied. They were as follows:

1. Comparison of various whole grains as feeds for fattening lambs. The grains fed, in the order of their relative feeding value, were Thayer corn, local grown Reid Yellow corn, barley, Baart wheat, Turkey wheat, Jenkin wheat, and oats.

2. Value of whole grains as compared to steam-rolled and ground grains, namely: wheat, oats and barley. Except in the case of steam rolled oats, processing did not materially increase the feeding value of these grains. In most cases the feeding value of processed grains was somewhat less than for the whole grains.

3. Comparative feeding value of corn silage, cull potatoes chopped, cull potatoes whole, and chopped cull apples. The addition of all succulent feeds increased the rate of gain over that of lambs receiving no succulent feeds. Cull potatoes and cull apples produced greater gains than corn silage when fed at the same rate. Potatoes fed whole produced slightly better gains than those fed chopped. All potatoes and apples were carefully sorted for rot before feeding.

Orchard Irrigation. (a) Moisture Relations. (C. A. Larson). Orchard irrigation experiments performed this year were continuations of those last year. Three plots that had been clean cultivated previous to 1931 when they were seeded to alfalfa were designated as Plots 1, 2 and 3 and are included in the series receiving the same treatment as Plots 1-a, 2-a, and 3-a, namely, an irrigation every 30 days allowing the water to run 18, 24, and 36 hours respectively. The water applied to each plot was carefully measured by means of a submerged orifice. Surface runoff water was measured over a 90-degree angle notch weir on which a water stage recorder operated. Plots 4, 5, and 6 received the same treatment as last year, namely, water applied every 15 days with 9, 12 and 18 hour runs respectively. Soil samples were taken before and after each irrigation at six representative locations to a depth of six feet on each plot. One core was taken in the corrugation and one between corrugations to make a sample of each foot level. Soil samples showed the penetration of water on the various plots as follows: Three plots that had been clean cultivated showed poor water penetration. There was no increase in the moisture content beyond the fourth foot even when the greatest amount of water was applied, whereas on Plots 1-a, 2-a and 3-a the minimum depth of penetration

was four feet and the maximum well beyond the sixth foot. Plots receiving water every 15 days showed that the water penetrated almost to the third foot in 9 hours and not much farther in 12 hours. However, with an 18-hour run every 15 days, water penetrated beyond the sixth foot as shown by the saturated condition of the sixth foot. The total acre inches of moisture used by plants for the season for the various plots were as follows: 1, 26.8; 2, 29.0; 3, 33.5; 4, 33.6; 5, 41.5; 6, 44.8; 1-a, 30.8; 2-a, 41.0; 3-a, 46.7. The amount of moisture withdrawn from the reserve in the first to the tenth foot has been added to the net application. Runoff water on Plots 1, 2, and 3, the newly seeded plots, was very high and the maximum runoff amounted to 50 per cent of the water applied and the minimum to 35 per cent. The runoff on Plot 4 amounted to an average of 12 per cent; on Plots 5, 6, and 2-a, 20 per cent; and Plot 3-a, 35 per cent. The alfalfa cover crop slowed up the flow of water somewhat and was therefore an aid to penetration in the soil. The root system loosens the soil, and aids penetration. These conditions were not present in the newly seeded plots.

(b) Tree and Fruit Responses. (L. L. Claypool). During the 1932 growing season air temperatures were relatively lower than in 1931. Consequently trees receiving the light seasonal application of 30 acre inches of water did not show as severe distress as in 1931. However, on these lightly irrigated trees conditions have been unfavorable to such a degree that the formation of fruit buds in 1931 was limited. As a result great differences were found in yield and thinnings removed from Rome and Winesap trees in Plots 4 and 1-a as compared to other plots.

Trees in Plots 1, 2, and 3 that had been in clean cultivation previous to 1931 suffered from lack of water with little or no regard to the amount of water applied. Fruit was small and tree growth poor on all these plots. This distress was due to poor penetration of the water applied.

On trees in Plots 4, 5, 6, 1-a, 2-a, and 3-a, yield of fruit, leaf size, terminal growth, and girth of trunk increased as more irrigation water was applied. Color of Delicious fruit also was enhanced by more water. Size of fruit was generally better on trees as the water supply was increased except where the crop was very small on Winesap trees in Plot 4.

Fruit stored following the 1931 season showed no correlation between keeping quality of Rome and Winesap fruits and irrigation treatment. The alfalfa cover crop did not show marked signs of distress from insufficient water except on Plots 1, 2, and 3.

Orchard Fertilization. (L. L. Claypool). 1. The second application of fertilizer to the fertilizer plots in F. A. Norton's d'Anjou orchard

at Grandview, Washington, was made in February and early March. Nitrogen was applied at the rate of three-fourths pound per tree and phosphorus and potash at the rate of one pound P_2O_5 and one pound K_2O per tree respectively. Each plot contains at least 20 fertilized trees of which the center five or six are used for records. The alfalfa and sweet clover cover crop has been gradually depleted until the stand is poor. At the end of the second season following fertilization little or no effects from the fertilizer treatments are discernible, although trees receiving nitrogen seem to have a little darker green foliage than others. No consistent differences in yield and size of fruit or tree growth have been found.

A high percentage of fruit produced in 1931 and 1932 was affected with "cork spot." This trouble seems to be related definitely to Japanese root stock. The same trees that ran heavily to "cork spot" fruit in 1931 were affected similarly in 1932. There seems to be no relation between severity of "cork spot" and fertilizer treatment.

2. Several "indicator crop" fertilizer plots were established in cooperation with the Agronomy Division in orchards where trees 20 years old or older recently had been removed. Wheat was used as the indicator crop since it responds readily to fertilizer treatments. Nitrogen is the only element to which marked response was shown although there was an indication of benefit from phosphorus in one series of plots. There was no response from the application of potash.

Orchard Pruning. (L. L. Claypool). Severe, moderate, and light pruning treatments have been continued in the station orchard as in previous years. The trees range in size inversely with the severity of pruning. Because of their larger size the lightly pruned trees have had nearly as much wood removed as the severely pruned trees during the last three years.

In 1931 the yields in 40-pound boxes were as follows: Romes, lightly pruned, 19 boxes; moderately pruned, 8 boxes; severely pruned, 6 boxes. Winesaps, lightly pruned, 20 boxes; moderately pruned, 20 boxes; severely pruned, 11 boxes. Size and color of fruit increased with the severity of pruning.

In 1932 the lightly pruned trees showed evidence of approaching alternate bearing indicated by a relatively light bloom and subsequent low yields. Indications are that very light pruning in the first six or eight years following planting of an orchard will result in early bearing and earlier full bearing due to the production of a large tree, but that when the tree growth begins to slow up the severity of pruning will need to be increased in order to obtain sufficient vigor and keep the tree in an annual habit of bearing.

Rosette or "Little Leaf" Studies. (L. L. Claypool). In a survey in 1931 of apple orchards affected with little leaf or "rosette" as it has commonly been called in Washington, it was found that affected trees usually were brought back to normal by a good alfalfa or clover cover crop in its second or third year. Many orchards where the cover crop had been removed or greatly thinned out reverted back into a little leaf condition. No benefits were observed in affected orchards from any fertilizer treatment or cultural practice other than the growing of a legume cover crop.

A number of trees were treated in 1932 with zinc sulfate, a chemical that has given promising results in California. Treatments ranged from about one ounce of zinc sulfate injected into the trees to 40 pounds spread onto the soil underneath the trees. The injection method resulted in striking benefits to treated trees notwithstanding their very poor original condition. Benefits were also apparent from the application of large quantities of zinc sulfate to the soil, but this method is expensive. These studies will be continued more extensively in 1933.

Leaf Area Studies of Cherries and Peaches. (L. L. Claypool and E. L. Overholser). In 1932 restricted leaf area studies were made with Napoleon (Royal Ann) cherries and J. H. Hale peaches by thinning branches to varying leaf-fruit ratios. Indications are that the leaves adjacent to the peach fruit are largely responsible for the set of the fruit and its subsequent size. Cherries, however, were found to mature to a fair size on branches not ringed even when the nearest leaves were more than 12 feet away. A variation ranging from one-half leaf per fruit to eight leaves per fruit on branches not ringed did not greatly influence the size and chemical composition of the fruit. On ringed branches, however, the size and color of cherry fruit and reducing and total sugars increased directly as the number of leaves per fruit was increased, whereas nitrogen and moisture decreased.

Fruit Variety Trials. (L. L. Claypool). About 12 of the 32 plum varieties growing in the variety orchard produced some fruit in 1932. Within the next two years all of the varieties should be fruiting, including a number not now grown on a commercial scale. Climax, Wickson, Burbank and Formosa were the most promising varieties that fruited this year.

Over 20 varieties of apples were grafted into old trees during the last two years. A few of these already are producing fruit. Lodi, a large attractive yellow apple, was outstanding among the varieties that fruited in 1932. It is almost as early as Yellow Transparent and is of good quality.

A number of peach varieties produced fruit in 1932 for the first time. Many of them are of excellent quality and may become valuable commercially.

Cover Crop Studies. (L. L. Claypool). The cover crop plots of alfalfa and biennial white sweet clover were continued. The first planting of sweet clover has gone through its life cycle. These plots will be reseeded next spring. Following the completion of the next life cycle indicator crops will be grown on both alfalfa and sweet clover plots for at least two years to determine relative amounts of nitrogen in the soil.

Potato Fertilization. (L. L. Claypool). The potato fertilizer plots were continued for the fourth consecutive year and the second year on the same soil. The rate of application of fertilizers used in the trials was 160 pounds of K_2O and P_2O_5 , 180 pounds N per acre in the forms of potassium sulfate, treble-super-phosphate, and ammonium sulfate. In 1929 and 1930 beneficial responses were evident only from the applications of nitrogen. However, in 1931 and 1932 phosphorus applied with nitrogen resulted in increases in yield that seemed to be due to phosphorus as well as nitrogen. No beneficial response has yet been evident from phosphorus or potash applied either alone or combined with each other. If sufficient nitrogen were already present in the soil phosphorus might be beneficial when applied alone.

Lettuce Fertilization. (L. L. Claypool). The lettuce fertilizer plots were continued again this year, making three years that the same plots have been studied. The application of nitrogen was increased from 120 to 180 pounds of nitrogen per acre. P and K were applied at the rate of 160 pounds of P_2O_5 and K_2O respectively.

Manure gave the greatest increase in size and firmness of head, and early maturity over the check plot, but plots receiving NP or NPK were almost as good. Little or no benefit was realized from P and K applied alone or in combination. An application of NP produced a yield that was greater than the combined yields of N and P used alone.

Lettuce seed has been produced on these fertilizer plots during the 1931 and 1932 seasons. Yield records in 1932 varied from as low as 265 pounds per acre on some plots receiving no fertilizer to as high as well over 1000 pounds per acre on plots receiving nitrogen and phosphorus or manure. Larger seed was produced on the latter plots than on those where no nitrogen was applied.

Lettuce grown from seed produced on these plots compared favorably with lettuce grown from similar seed produced in other sections

In cooperation with E. L. Overholser of the Division of Horticulture at Pullman, respiration studies were made on lettuce heads

from the fertilizer plots. Nitrogen applied alone seemed to increase respiration, whereas phosphorus applied with nitrogen retarded respiration. Differences were not great enough to affect the commercial quality of the heads.

Water Measurement. (C. A. Larson). There are three headgates through which water is diverted for the experiment station. At two of these submerged orifices are used on which Great Western water meters operate. On No. 2 headgate, a Cippoletti weir and a water stage recorder are used. Water measurement on experimental plots is carried out by means of submerged orifices and water meters. In the case of the orchard irrigation plots the flow of water was actually measured in a barrel in order to calibrate the submerged orifice through which the water flowed at a given pressure. Water was measured on farm fields under No. 2 headgate by means of the water stage recorder, the amount of water being calculated from the record sheet of the recorder.

Irrigation Experiments with Crops. (C. A. Larson). Amounts of water as shown applied to the crops in the irrigation plots refers to the net application, considering the moisture in the soil at emergence of plants, the amount remaining in the soil after the crop was harvested and the estimated amount of runoff water. These amounts would necessarily be much higher if transportation and runoff losses were added. Five irrigation plots each of alfalfa, potatoes, corn and wheat were investigated this year. Soil samples were taken on each plot as the plants emerged and again on each plot after the crop was harvested. The application of water on alfalfa plots ranged from two acre feet to five acre feet. Six and four-tenths tons of air-dry alfalfa hay were produced with 38 acre inches of water. At the beginning of the season there were seven acre inches of moisture available in six feet of soil and after the third cutting there were 11.8 acre inches. The greatest yield of hay was obtained from three acre feet of water on an alfalfa basin plot, designed to eliminate runoff water.

Applications of water to five wheat plots ranged from 13 to 24 acre inches and the highest yield was 57.4 bushels produced with 22.7 acre inches. There were 41.6 bushels of wheat produced with 13 acre inches. On this plot there were 31.3 bushels of grain per ton of straw.

Sixty bushels per acre of corn were obtained with 22.2 acre inches of water. On an adjacent plot 55.2 bushels were produced with 12.6 acre inches. Forty-seven and two-tenths bushels per acre of corn were harvested on Plot 5, which used 24.4 acre inches of water.

A potato crop using 36 acre inches of water produced 11.7 tons of potatoes which was the highest yield of the five plots. A yield of 7.6 tons was produced with 20.3 acre inches.

Specific Conductance of Irrigation Water. (C. A. Larson). Water samples were taken at weekly intervals from the Sunnyside canal and the Yakima river. The total salt content of the water of the Sunnyside canal was rather high during the first part of the period after diversion. This is supposedly due to the considerable surface runoff in the mountains. During this period the total salt concentration ranged from 80 parts per million to 96 parts per million. At the same period concentration of the total salts in the Yakima river ranged from 102 to 125 parts per million. During the period from May 14 until June 18, the concentration of the water in the Sunnyside canal showed a steady decline in total salts, reaching a minimum concentration of 60 parts per million on June 18. From June 25 until the middle of August the concentration of the Sunnyside canal reached its highest point of 100 parts per million, whereas the concentration of the water of the Yakima river reached a maximum of 327 parts per million the latter part of August, the increase being rather steady from the first of July.

Specific Conductance of Soil. (C. A. Larson). Specific conductivity determinations were made on samples of soil from the station orchard taken to a depth of six feet on plots receiving irrigation ranging from 30 to 60 acre inches per season. There was no perceptible difference and the concentration ranged around 173 parts per million.

Conductance determination of salty soil near Sunnyside showed asparagus growing poorly where concentration was 1150 parts per million in the third foot and 264 parts per million in the first and second feet.

Flume Repair Materials. (C. A. Larson). Petrolastic cement and roofing cement were applied to wooden flumes this year to determine their value in stopping leaks. Roofing cement is the cheapest material but the action of water and silt will gradually wear it away. Petrolastic cement can be used beneficially on cracks in the bottom of flumes provided it is applied hot enough to penetrate the thin layer of surface wood. The cost of material, labor of cleaning the flume and applying the material will range from two to four cents per foot.

CRANBERRY BRANCH STATION

D. J. Crowley in Charge

The season's studies followed chiefly the lines of the past two years, with special attention being given to the control of scale insects. Considerable attention was given this year to the cultivated

blueberry (*Vaccinium corymbosum* L.) especially to methods of propagation.

Dormant Sprays for Scale Control. The first dormant sprays of the season were applied in December. Other applications at the same strength were made in January, February and March. The last applications at the dormant strength were made on March tenth. On December first a plot was sprayed with liquid lime sulphur 32 Beume at a dilution of one gallon of lime sulphur to ten gallons of water. Adjacent plots in the same tract were sprayed on January fourth, February fourth and March tenth. Better control of scale was noted in the plots sprayed in February and March than in December. This was at least partially due to the fact that heavy rains in December and January washed off much of the spray. In all plots, however, control of both oyster shell and Putnam scale was satisfactory.

Due to the comparatively cool climate on the Ilwaco Peninsula much of the lime sulphur remains on the vines until the end of June. Each warm day in May and June sulphur fumes could be noted in all bogs which received a lime sulphur spray in the winter. The fact that the sulphur remains active for so long a period is one reason why it is a better scalecide in a cranberry bog than an oil spray. It is impossible, owing to the dense mat of vines and foliage, to reach all scale infested stems with either spray. There is little doubt from the results obtained that the fumes of the sulphur killed many of the scales not reached by the liquid spray. Many of the migratory scales were also killed by sulphur fumes.

Plots adjoining the above with the same degree of scale infestation as nearly as could be determined were sprayed on the same dates with a dormant oil, viscosity 100 and unsulfonated residue 60. The average of scale spotted berries from the oil sprayed plots was three per cent while in the lime sulphur plots there was an average of less than one per cent spotted fruit. From these tests and observations taken in dozens of the commercial bogs during 1932 it is clear that lime sulphur is at present the most practical spray for scale control in the cranberry bogs.

Dormant Sprays for Fireworm. Plots one-tenth of an acre in size were sprayed with various brands of commercial oils manufactured for dormant sprays. Adjoining plots were sprayed with oils No. 5 and No. 7. The latter were supplied by the Standard Oil Company of California to members of the Northwest Oil Spray Conference. Oils were used at 1, 2, and 3 per cent actual oil content. The average kill of fireworm eggs increased from 50 per cent in the plots sprayed with 1 per cent oil to 75 per cent for the 2 per cent oil and 80 per cent in the plots sprayed with 3 per cent oil. No injury from the oil was

noted to fruit buds in the plots sprayed with the 1 and 2 per cent oil but the 3 per cent oil sprayed plots showed about 10 per cent injury to the fruit buds. This agreed exactly with the results obtained in 1931 and shows that a 2 per cent oil applied in the dormant season is a valuable spray for fireworm control. A bulletin on oil sprays for the cranberry fireworm will be issued this winter.

Cotton Ball Fungus (*Sclerotinia oxycocci* Wor.) Certain bogs in the past two years had a high percentage of loss caused by the cotton ball fungus (*Sclerotinia* sp.). Though Bordeaux sprays reduce the percentage of loss caused by this organism, two or more sprays usually are required to hold it in check. Adjacent plots which had a large percentage of cotton ball berries last year were sprayed as follows: Plot 1 received a 3 per cent lime sulphur spray. Plot No. 2 received a 4-4-50 Bordeaux spray when the buds started to break, another spray 10 days later and a third when the blossoms were almost at the hook stage. An unsprayed plot was left as a check. Plot No. 1 showed less than .5 per cent cotton ball berries while plot No. 2 had about 5 per cent infected fruit. The check plot had about 15 per cent cotton ball berries. Storage tests are being carried on with the berries from the sulphur sprayed plots to determine whether a dormant sulphur spray can be used to replace the Bordeaux sprays. The results from last season showed an improvement in the keeping quality of the berries sprayed with lime sulphur in the dormant season over the unsprayed check.

Fireworm. A complete program of summer oil sprays again was tried this season. The results obtained this year confirm the conclusions reached from other seasons' work, namely that more than two summer oil sprays cause definite injury to the cranberry plant. This injury shows in a yellowing of the foliage and a smaller set of fruit buds for the following season.

Nicotine Tannate. Experiments were carried on this season using nicotine tannate at dilutions of from 1 to 1000 to 1 to 400 for fireworm control. Excellent control was obtained with nicotine tannate at a rate of 1 to 500. When used at the rate of 1 to 400 for control of the cranberry fruitworm the number of injured berries was less than 5 per cent. The season's work indicates that nicotine tannate is a more effective control for both the cranberry fireworm and the cranberry fruitworm than nicotine sulfate. However, it costs more per spray than the pyrethrum sprays now in general use here.

Processing Cranberries and Blueberries. Berries again were sent to the U. S. Department of Agriculture Frozen Pack Laboratory at Seattle. The results obtained in last season's work were very satisfactory and definite conclusions will be available when this season's work is concluded.

Chemical Analysis. Results from the chemical analysis conducted by Professor R. P. Cope of the Chemistry Department at the State College also will be published at the conclusion of this season's work.

Blueberries. The blueberry crop at the station plot was an excellent one this season. Though the berries were sold at a lower price the returns were slightly more than from last year's crop. In addition to those sold, about 50 pounds were sent to the Frozen Pack Laboratory for experimental work. More attention was given the blueberry work this year, especially to methods of propagation. Soft wood cuttings were taken from the bushes as early as the end of May and they calloused in about six weeks. No roots, however, were formed until about the end of August. Cuttings also were taken in June, July, August and September. The percentage of rooted cuttings from July, August and September cuttings was less than those taken in June, though many of the cuttings taken as late as September 15 with fruit buds already formed have calloused and some are already rooting. A bulletin describing the method used in propagation will be published early in 1933.

Spray Equipment. A new spray plant was installed early in 1932. This plant operates at about 400 pounds pressure and has increased greatly the efficiency of the spray work.

PACIFIC NORTHWEST SOIL EROSION AND MOISTURE CONSERVATION EXPERIMENT STATION¹ :

W. A. Rockie in Charge

Vegetative Control of Erosion. (W. A. Rockie and A. J. Johnson). Setup No. 1. This setup was described in detail in the 1931 report. Plot 15 has been added to this setup during the present year. The surface soil was removed from this plot to a depth of 16 inches and heavy "red clay" from an adjoining slope was added to replace the amount removed. This plot is to be cropped identically with Plot 14.

The erosion in this region during the winter of 1931-32 was probably of more than average severity.

During 1932 soil losses from summer fallow seeded to winter wheat were very heavy, though not quite as great as from untilled, uncropped hard fallow. Any vegetative cover at all resulted in a remarkably decreased amount of runoff and erosion, although different

¹The U. S. Department of Agriculture cooperating with the State College of Washington.

²Published as U. S. Department of Agriculture Outside Series No. 1105

vegetations were effective in varying degrees. The stubble of winter wheat almost completely stopped runoff and erosion. Spring wheat stubble, sweet clover, and grass sod were somewhat less effective, but all of these resulted in a fractional loss in comparison with fallow conditions.

The relative erosivity of "clay points" as compared to ordinary Palouse soil is rather striking. With winter wheat stubble as the vegetative cover, the "clay points" had about 10 times as much runoff as did typical Palouse soil and lost more than 20 times as much soil.

The result of subsoiling was measured in one of these plots and it showed that subsoiled land absorbed two inches more water than did land under ordinary tillage. Since larger fields nearby have not corroborated this result, additional time is necessary for reliable information on this point.

Setup No. 2. During the two years 1931 and 1932 it has been seen that the steep north slopes represent the extreme erosion problem in this region. A set of six plots of 1/100 acre each has been established on a northeasterly 48 per cent slope. Two of these plots are planted to winter wheat for the 1933 crop to be followed by fallow, and two others will be summer fallowed in 1933 and planted in winter wheat the succeeding year. The fifth plot will be in alfalfa and the sixth in grass in 1933. One of the plots seeded to winter wheat is being prepared so that a movable cross divider can be set into the plot at the lower edge of the snowdrift, this setting to be varied as the extent of the snowdrift increases or decreases. The purpose is to separate and evaluate snowdrift erosion as against ordinary slope land erosion. One of the two plots given over to summer fallow in 1933 will be treated in like manner. A two inch pipe has been buried in these plots so that runoff from above this cross divider can be diverted into it (tees installed every four feet throughout the length of the plot). This pipe will empty into a separate tank in the building below.

This setting represents the extreme erosion in this region. It is known that erosion on northerly slopes causes from several to many times the soil loss incurred on southerly slopes but the actual amount of the soil loss is not known.

Terracing Studies. (P. C. McGrew). Experimental terraces were completed on an area of 25 acres. They were constructed on slopes varying from 14 to 40 per cent. The average cost was \$4.44 per acre. The cost was as low as \$1.78 per acre for the wider spacing and if the wider spacings are satisfactory the average cost of \$4.44 per acre could be reduced considerably. The cost per acre for the more gentle slopes is considerably less.

Runoff and soil loss were measured from two adjacent areas, one being terraced and the other unterraced. From December 18, 1931 to

April 2, 1932 the total precipitation was 13.31 inches. On the unterraced area the runoff, during this period, was 5.0 inches or 38 per cent of the rainfall. On the terraced area the runoff was 1.3 inches or 10 per cent of the rainfall. The water loss from the unterraced area was nearly four times greater than for the terraced area. The proportion of soil lost for the unterraced area was even greater than the water loss. Comparative crop yields of winter wheat on the two areas gave a slightly larger yield for the unterraced part. The experience has been that terraces do not produce as well the first year after construction and this single year should not be considered conclusive.

Operation of Machinery on Terraced Land. (P. C. McGrew). The terraced land was in winter wheat during the 1931-32 season. The crop was planted with an ordinary drill and harvested with a combine harvester. Best results were obtained by operating the machinery parallel to the terraces. The time required to harvest the terraced land was estimated by the operator to be 20 to 25 per cent longer than on unterraced land. No accurate comparison could be made due to the small area of terraced land. It was noticeable that the ditches washed down the slope on the terraced land were only a fraction as large as on the unterraced land and caused no trouble in harvesting while on the unterraced land the combine had to cross the ditches carefully to avoid damaging the machine.

Tillage Experiments. (W. A. Rockie and P. C. McGrew) The erosion of fields following summer fallow is more severe than following other conditions. A series of plots was started during the spring of 1932 to study the effect of different summer fallow methods on erosion and crop yield. The stubble was burned from alternate plots. The common field practice of many farmers is to burn the stubble. One area was plowed with a mold-board plow and weeded with the rod weeder, the area including both burned plots and plots with the stubble turned under. The other area was disked with an ordinary tandem disk and weeded with the same implement. This area included both burned and unburned plots. Where the ground was plowed the stubble was practically all in one layer about six inches below the surface and where the disk was used the stubble was mixed with the surface soil to a depth of about five inches. Soil moisture determinations were made throughout the summer season and the area planted to winter wheat in the fall. Records will be kept on the erosion under the different conditions and crop yields will be obtained in 1933.

An experimental area, where the stubble was heavy, was fall plowed with a heavy tandem disk plow. The erosion and crop yield will be compared to plots having deep tillage, spring plowing, and various fertilizer applications.

Studies were continued with the hole digging cultivator both at the Erosion Farm near Pullman and the Adams Branch Station, of the State College, at Lind.

Studies were continued with the deep tillage implement. One of the small controlled plots having deep tillage of a slightly different character had less erosion and runoff, and an increased crop yield compared to plots with ordinary tillage. These benefits were not apparent on the field areas and the work is being continued.

Meteorological Records. (A. J. Johnson). Two recording, three standard and two experimental rain and snow gauges are maintained at strategic points on the soil erosion farm. A recording hygro-thermograph, a recording barograph, and maximum and minimum thermometers constitute the weather recording instruments that are part of the station equipment. Records are also kept of the prevailing wind direction and the character of the day. Records are taken between 7 and 8 A.M. each day.

Soil Moisture Investigations. (W. A. Rockie). It now appears conclusive that the fallow system in the Palouse region is primarily responsible for the very severe erosion which occurs on winter wheat following summer fallow. A limited number of determinations during 1931 indicated this fact, but during 1932 sufficient determinations have been made to establish definitely that the fallow system is a primary cause of the erosion on winter wheat.

The summer fallow land is practically saturated, except in the upper six inches of soil, when the first fall rains occur. The first few inches of precipitation saturate this surface layer and the remainder of the winter's rainfall must, to a very large extent, run off from the surface. This is the answer to the question, "Why do winter wheat fields erode worse than any other land?"

Crop Yield Sample Plots. (W. A. Rockie and P. C. McGrew). This project was continued from the preceding year. The 1932 yield sampling covered all of that portion of the farm that had a 1932 crop of wheat or peas. Detailed yields for 1932 were not available for this report, but in general they corroborate the results of the preceding year.

Producing Power of Gray Alluvial Soils. (W. A. Rockie and P. C. McGrew). The gray alluvial bottom soils of the Palouse region represent a problem either of unfavorable soil or moisture conditions, or both. A quantity of this low-producing gray soil was moved and spread over part of a clay point, immediately adjoining a similar plot covered with rich black soil. The experiment will show definitely whether the gray soil will produce as heavily as Palouse silt loam when drainage conditions are satisfactory. This area was in winter wheat in 1932.

Producing Power of Rich Black Soil on Ridgetops. (W. A. Rockie). How does the production of a certain rich soil condition on a basal slope compare to the production of an identical soil condition on the top of a ridge? To answer this question plots were established on a saddle-like ridge of exposed clay. Different plots were covered with 2, 6, 12 and 24 inches of rich black soil, an equal amount of clay first being removed resulting in a practically level surface.¹ This was done in the early summer of 1931. The land was fallowed in 1931 and was in winter wheat in 1932. The black soil produced a very much more luxuriant growth, which "burned" severely in droughty weather, but the yields were not available for this report.

Covering Outcropping Clay Points with Black Soil. (W. A. Rockie and P. C. McGrew). This experiment is being continued over a number of years. A much healthier, more luxuriant growth of grain occurred this year, with the naturally greater amount of "firing" of the crop in protracted drought. The comparative yields will be available for the succeeding year.

Fertilizer Plots on Clay Hilltops. (W. A. Rockie). The purpose of this experiment is to improve the physical condition of the soil on outcropping clay points by the application of various fertilizers so that the soils of these areas may become more receptive of moisture, and by the same treatment, to improve the crop yield from such areas.

Those plots having nitrate fertilizer showed a prolonged period of vegetative growth both in 1931 and 1932, the plants ripening from two to three weeks later than in the unfertilized checks.

The different plots showed no outstanding erosional difference at the end of the erosion season of 1931-32, while the 1932 crop yields (winter wheat) are not yet available.

Fertilizer Applications for Stubble Decay. (W. A. Rockie cooperating with Geo. W. McCallum, distributing agent for fertilizers for the Consolidated Smelting and Refining Company, Ltd., Trail, British Columbia) A series of half-acre plots, alternating with sixth-acre check plots, have been established in the fall of 1932 in heavy wheat stubble. The fertilizer was applied to the heavy stubble and this was followed by disking once with a heavily-weighted 22 inch tandem disk. Observations of the degree of stubble decay and of soil moisture will be made throughout 1933, as well as of the crop yields on the different plots.

Plots 1, 3, 5, 7, and 9 of the series are 1/6 acre check plots. The treated plots were fertilized as follows:

¹The two-inch mantle was placed on top of the old surface without excavation and this will of course be lost in the upper six inches after the first cultivation.

Plot 2	100 lbs.	16-20	Ammonium Phosphate per acre the fall of 1932
	80 lbs.		Ammonium Sulphate per acre the spring of 1933
Plot 4	100 lbs.	16-20	Ammonium Phosphate per acre the fall of 1932
Plot 6	80 lbs.		Ammonium Sulphate per acre the fall of 1932
Plot 8	80 lbs.		Ammonium Sulphate per acre the fall of 1932
	80 lbs.		Ammonium Sulphate per acre the spring of 1933

Effects of Fertilizer upon Soil Conditions and Upon Yields. (W. A. Rockie cooperating with S. C. Vandecaveye of the Soils Section, Washington Experiment Station, and with Geo. McCallum, fertilizer distributor for the Consolidated Smelting and Refining Company, Ltd., Trail, British Columbia). These fertilizer plots were established by Mr. McCallum and the results were available on many farms in the Palouse region. The experiments included different rates of application of treble super phosphate, of 16-20 ammonium phosphate and of ammonium sulphate.

Effect on Erosion of Hogging-Off Waste Peas. (W. A. Rockie and P. C. McGrew). A visual examination of the adjoining hogged and unhogged areas showed no difference in runoff and erosion. The hogs ran on these plots only in the fall before the soil was wet. Hogging the land after the fields become muddy would very likely increase erosion, although this contrast was not measured.

Date of Planting Experiment. (W. A. Rockie and P. C. McGrew). The purpose is to determine if, by early drilling, sufficient vegetative cover can be developed to materially retard runoff and erosion as compared to winter wheat at the normal date of seeding.

Plots of 1/6 acre each are to be established on summer fallow land, beginning the seeding about September 10 and repeating every 10 days thereafter until late October.

Ordinary field methods will be used, even though soil moisture conditions are usually unfavorable for the success of such an experiment.

Comparative Study of Spring Wheats in their Relation to Moisture Conservation. (W. A. Rockie and P. C. McGrew cooperating with O. A. Vogel of the Bureau of Plant Industry, U. S. Department of Agriculture). The use of spring wheats possesses several advantages over winter wheats, from the erosion standpoint, and several of the leading spring wheats are being tested in plots over a period of years on fallow and on stubble, checking yields and soil moistures when the plots are harvested. The initial plots were established in 1932.

Utilization of Clay Points by Planting to Timber Cover. (W. A. Rockie and P. C. McGrew, cooperating with the Forestry Department of the State College of Washington). A narrow ridge which projects

toward the northwest from one of the hills has been planted to parallel rows of Norway Spruce (*Picea excelsa*), Douglas Fir (*Pseudotsuga taxifolia*), Black Cottonwood (*Populus trichocarpa*), Black Locust (*Robinia pseudoacacia*) and Chinese Elm (*Ulmus pumila*). A single row of the first named species was planted at the top of the steep break on the leeward side of the hill, with two rows of Douglas Fir next to the windward. These three rows extended almost to the ridgetop. On the windward slope, immediately adjacent to the rows of Douglas Firs are five rows of Black Locust, and two rows of Chinese Elm are on the windward front. A solid block of Black Cottonwoods was planted at one end of these rows. All trees were planted six feet apart each way. The Norway Spruce trees were 3-2 transplants; the Douglas Firs, 2-2 transplants; the Black Cottonwoods, two year old from cuttings; the Black Locusts, one year seedlings; and the Chinese Elms, two year seedlings. The number of trees planted was as follows: Cottonwood 61, Chinese Elm 79, Black Locust 210, Douglas Fir 109, and Norway Spruce 56.

The ground will be kept clean cultivated during the summer of 1932 and possibly also in later years. The effects upon the soil and upon the drifting of snow, the growth of the trees for fuel and for posts, the amount of time gained in spring farming of the north slope due to lesser snowdrifts, the effect on farming operations, the value of the tree cover for shade purposes (both for pasturing of stock and for recreation) and such other records as appear advisable will be kept.

Strip Cropping. (W. A. Rockie and P. C. McGrew). Plans for strip cropping have been completed. These include the planting of strips of winter wheat in June (in a summer fallow field), pasturing the summer fallow and strips during the summer to prevent heading out, and then seeding the remainder of the field to winter wheat at the usual season. The same plan also will be tried using strips of a spring wheat which will be harvested from the fallow field.

Machinery operation in connection with strip cropping is being studied.

It is planned to leave check areas unseeded to show the erosional contrasts which result.

Cooperative Projects with Smith Hughes Teachers. (W. A. Rockie and P. C. McGrew cooperating with teachers of Smith Hughes agriculture) Plans are practically completed for the establishment of strip cropping experiments and gulley control by sod and dams in different parts of this region. The various agricultural workers of their respective communities will carry on the experiment under suggestion and observation by the soil erosion station.

Wind Erosion Studies. (W. A. Rockie and P. C. McGrew). Preliminary studies of soil drifting have been made at intervals during the past two years and arrangements have been practically completed for a long time study of this problem on a "badly blown" farm near Cunningham, Washington. This farm hereafter will be designated as the Cunningham Substation of the Erosion Station. The investigational work at the substation will include: (a) detailed studies of the natural vegetative successions on such lands and (b) research into practical and quicker methods of returning such areas to practical agricultural uses. The Farm Crops Section, the Forestry Department and the Adams Branch Station, all of the State College of Washington, are active cooperators in this project.

Regional studies of the area affected by soil drifting are being added to as time permits.

Effect of Erosion on Cost of Farm Operations. (P. C. McGrew) The erosion during the winter of 1931-32 was much more serious in most localities than during the previous winter. Many farmers report a much smaller acreage harvested per day during 1932 than the previous year. Also the number of breakdowns of machinery was large, especially those caused by operating machinery over rough ground. The cost per day for operating the combine does not vary greatly whether operated on smooth ground at full speed all the time or on rough ground where it is necessary to slow down in crossing each gully, providing there are no stops due to breakage. The cost per acre, however, varies. For example, if the normal day's run was 25 acres per 10 hour day at a cost of \$2.00 per acre, the daily cost would be \$50.00. If only 20 acres could be cut per day due to slowing down for gullies, the daily cost would still be \$50.00 but the cost per acre would be increased from \$2.00 to \$2.50. Thus, if the season's run was 500 acres the increased cost would be \$250.00 neglecting any increased costs due to breakage. Actual harvesting records are being collected which will show the increased costs due to erosion.

Erosion Survey of Severely Eroded Area near Colfax, Washington. (W. A. Rockie and P. C. McGrew). Observational studies of this area(first reported in last year's experimental work) were continued, showing the disastrous and lasting effects of such rains. The initial investigations of this type of storm have been assembled and summarized for publication by the Washington Agricultural Experiment Station in Bulletin 271.

Erosion Survey of the Northwest. (W. A. Rockie). Additional field work has been done at intervals during the year toward a general knowledge of the erosion conditions in the three states of the Pacific Northwest, although the work done still covers only a minor portion

of the total area within the three states. Additional time and field work are necessary for a complete picture of the conditions affecting erosion in this region.

Publicity. Newspapers of the Pacific Northwest have given generously both in their news and editorial space to carry the erosion facts to the people. During the past year, one newspaper alone has contained 85 inches of news referring especially to this regional station and its work. This paper is one of the many daily news-sheets within the regional scope of this station.

General and specific talks (ten in number) on soil erosion work were presented before various regional and community organizations and groups to a total audience of approximately 660 people.

During the year, five state-wide radio talks of eight minutes each were given over a hookup of eight radio stations. These broadcasts are a part of Farm Flashes prepared in the Office of Information of the U. S. Department of Agriculture. These talks were also given over the local broadcasting station at Pullman (not a member of this hookup).

Approximately 600 visitors personally inspected the experimental work that is under way at the erosion farm.

PUBLICATIONS

The following bulletins and scientific papers were published during the year July 1, 1931 to June 30, 1932.

General Bulletins

- 254 Methods of Feeding Leghorn Hens. Carver, J. S. 16 p. July, 1931.
A comparison of the efficiency of the mash and scratch grain method of feeding, all mash feeding, and pellet method of feeding laying hens.
- 256 Wheat Varieties of Washington in 1929. Gaines, E. F., and Schafer, E. G. 23 p. July, 1931.
Area and production of different wheat varieties are given by counties compiled from questionnaires from 760 farmers. In 1929 the six winter wheats, Hybrid 128, Triplet, Turkey, Riddit, Fortyfold, and Albit, and the six spring wheats, Baart, Federation, Bluestem, Jenkin, Marquis, and Thompson comprised 91.7 per cent of the entire crop. The adaptation and location of each variety are described in detail. The 12 leading varieties were classified according to federal grades. Eight of the varieties representing 57 per cent of the total production of the state were classified as white wheat.
- 257 Local Rural Leaders in Washington. Starling, Harvey W., and Yoder, Fred R. 35 p. September, 1931.
Factors influencing leadership were: participation in wide range of community activities, opportunities for public speaking, parliamentary practice, and committee work. Leaders read an average of one daily newspaper and four weekly, monthly, and semimonthly farm papers and magazines. Traits of successful leaders were: pleasing personality, tact, speaking ability, energy, practical knowledge of farming, unselfishness, and ability to mix well.
- 258 Lamb Feeding Experiments. Hackedorn, H., Sotola, J., and Singleton, H. P. 16 p. September, 1931.
This publication summarizes the last few years' work on lamb fattening rations. Shelled corn proved superior to wheat, barley, oats, and speltz. Chopping long alfalfa hay decreased the amount necessary to feed by nearly 17 per cent, and grinding decreased the amount by 29 per cent. Cull potatoes were rated slightly above and cull apples below corn silage as a succulent feed for fattening lambs.
- 259 The Effect of Certain Potato and Tobacco Viruses on Tomato Plants. Burnett, Grover and Jones, Leon K. 37 p. December, 1931.
Tests on apparently healthy commercial tubers showed that practically all potatoes grown in Washington are affected with a virus disease. Only one healthy tuber was found in tests with 655 apparently healthy tubers. Rugose mosaic has been shown to be caused by the presence of two viruses in the potato plant. Tests have shown the symptoms produced on tobacco and tomato plants by these viruses as well as their longevity in dried plant tissue. Methods of transmission of the latent, veinbanding, and tobacco mosaic virus are discussed.
- 260 Forty-first Annual Director's Report, 84 p. December, 1931.
This summarizes the work of the Washington Agricultural Experiment Station and expenditures for the fiscal year ended June 30, 1931.
- 261 Potato Flea-Beetles in Washington. Webster, R. L., Baker, Wm W., and Hanson, Arthur J. 20 p. April, 1932.
Early planted potatoes suffer most injury to tubers in western Washington. Contact sprays or dusts were not satisfactory in checking injury. Sodium fluosilicate dust one part, lime three parts, applied at 10-day intervals throughout the season gave the most protection to foliage and tubers, but was accompanied by slight injury to foliage. Barium fluosilicate dust (Dutox) one part, lime three parts, gave protection almost as satisfactory, without foliage injury.

- 262 Grain Elevating Machinery for the Palouse Country. Garver, Harry L. 34 p. March, 1932.
Types of elevators, their relative advantages and disadvantages, cost and depreciation, supplemental equipment, and the possible cracking of grain are discussed.
- 263 A Simplified Method of Standardizing Ice Cream Mixes and Correcting Offbatches. Bendixen, H. A. 24 p. May, 1932.
This bulletin describes a simplified method of standardizing ice cream mixes to meet (1) the state legal requirements, (2) to produce mixes of any desired composition consistent with the grade of ice cream to be made from them, (3) to maintain uniformity in the quality of the final product, (4) to enable the use of any available raw materials without changing the composition of the mix, (5) to prevent an increased cost of mix due to inaccurate composition control, (6) to find the most economical combination of raw materials possible for any desired grade of ice cream.
- 264 The Importance of Lenticel Infection of Apples by *Penicillium Expansum*. Baker, Kenneth F., and Hcald, F. D. 15 p. June, 1932.
Contrary to the generally accepted belief blue mold, *Penicillium expansum*, is shown to be able to penetrate uninjured apples through the lenticels. This type of decay seems to be the main cause of the high percentages of blue mold decay in storage or in transit to eastern terminals.
- 265 The Bactericidal Effectiveness of Home Laundering Methods for Silk and Rayon. Roberts, E. H. 24 p. June, 1932.
Tests with undergarments inoculated with *Escherichia coli* show that the present method of washing silk or rayon eliminates less than half of the bacteria; drying either indoors or out of doors eliminates approximately 99 per cent; and ironing approximately 100 per cent.

Papers Published in Scientific Journals

- 186 The Control of Cannibalism in Battery Brooders and Fattening Batteries. Carver, J. S. Poul. Sci. X, 5:275. July, 1931.
Cannibalism and feather picking in White Leghorn chicks closely confined in batteries or brooding rooms may be prevented by the use of natural ruby colored lights. Cannibalism and feather picking in broiler fattening batteries may be prevented by the use of natural ruby colored lights where the room is darkened and no other form of artificial light is used.
- 187 New Apple-Rot Fungi from Washington. Ruchle, George D. Phytopath. 21:1141-1152. December, 1931.
The fungi causing decay of apples in cold storage in Washington as determined from a detailed study are listed. Four new species are described and new data on several previously described species are recorded. The most important is the rediscovery of *Mycosphaerella tulasnei*, the perfect stage of *Cladosporium herbarum*.
- 187a Sources of Spores of Apple Decay Fungi. Huber, Glenn A. Proc. Wash. State Hort. Assoc. 27:10-12. December, 1931.
An analysis of the spore content of the air in orchards and packing plants with a determination of those causing decay. Determinations of the number of spores on the surface of normal apples. The dirty packing box as a source of contamination. The effect of cleaning processes on the spore load.
- 189 The Temperature at Which Unbound Water is Completely Frozen in a Biocolloid. St. John, J. L. Jour. Amer. Chem. Society 53:4014. November, 1931.
Using a freezing method for differentiating between bound and free water in a hydrophilic biocolloid, it is shown that a temperature of -12.5° is sufficient to freeze all of the freezable (free) water and that the remaining water (bound water) is not frozen at temperatures ranging between -12.5° and -35° . An improved formula for the calculation of free water is presented.

- 190 The Effect of Pasteurization on the Bacterial Flora of Low Count Milk. Black, L. A., Prouty, C. C., and Graham, R. A. Jour. Dairy Sci. 15:99-112. March, 1932.
This paper reviews a qualitative and quantitative study of the bacterial flora of low count milk. Results indicate that when milk of low initial bacterial content is pasteurized, the acid-producing bacteria are not of major importance in the spoilage of the milk.
- 191 A Study of the Gestation Period of Holstein-Friesian Cows. Knott, J. C. Jour. Dairy Sci. 15:87-98. March, 1932.
This study included 2824 gestation periods, the length of which varied from 262 to 296 days. Seventy-five per cent of all calves were dropped from the 275th to the 285th day. Only 1.7 per cent were carried for shorter periods than 270 days and 2.7 per cent were carried for 290 days or longer. Male calves were carried on an average of one day longer than female calves.
- 192 Angel Food Cake from the Thick and Thin Portions of Egg White. Hunt, Leila Wall and St. John, J. L. Jour. Home Econ. 23:1151. December, 1931.
The thin portion of the white on the average gives a cake a larger volume than the thick white. The white should be brought to room temperature (about 21° C.) before beating. A reasonable length of storage has little effect on the value of egg white for angel food cake. The length of the storage period probably has less effect than the temperature at which the white is beaten. These results are a further indication that discrimination against eggs with watery whites for cake making purposes is unjustified; in fact, they offer evidence that watery whites are more desirable than firm whites.
- 193 Relation of Strains of Nodule Bacteria and Fertilizer Treatments to Nodulation and Growth of Alfalfa. Vandecaveye, S. C. Jour. Amer. Soc. Agron. 24:91-103. February, 1932.
Alfalfa seed inoculated with nodule bacteria cultures from various sources was planted on several soil types in western Washington. Although satisfactory nodulation and a good stand of alfalfa were generally obtained, the alfalfa in all cases failed to make satisfactory growth the second and the third seasons. Application of lime and commercial fertilizers resulted in no marked beneficial effect, indicating that the soils were deficient in available mineral plant food which was not restored by a single application of commercial fertilizers.
- 194 The Functional Relation of Yearly Feed Cost and Butterfat in Dairy Cattle. Hodgson, R. E. Jour. Dairy Sci. 15:212-219. May, 1932.
This paper describes a statistical study of the relation between yearly feed cost and total yearly butterfat production in dairy cattle producing under average farm conditions. The study involved the analysis of 10,000 Dairy Herd Improvement Association records.
- 195 Tarnished Plant Bug Injury to Pears in Washington. Webster, R. L., and Spuler, Anthony. Jour. Econ. Entom. 24:969-971. October, 1931.
Damage to pears and apples by the tarnished plant bug was particularly severe in Washington in 1930. For a 14-day period beginning March 31 when pear blossom buds were swelling and particularly subject to injury, the effective temperatures (above 50° F.) were especially favorable in 1930, much less so in 1931 and still less in 1929.
- 196 Protein Requirements of Chickens. Carver, J. S., St. John, J. L., Aspinwall, T. E., and Flor, Iva Hansen. Poul. Sci. 11:45-57. January, 1932.
Several different levels of milk protein were fed throughout the entire growing period to White Leghorn chicks. The effects of feeding of these several levels of protein were studied with relation to the rate of sexual maturity, the size of eggs, and the efficiency of the use of the proteins.

- 197 Self and Cross Fertility of Red Raspberry Varieties. Hardy, Max B. Proc. Amer. Soc. Hort. Sci. 28:118-121. March, 1932.

Results of hand pollination on six of the most commonly grown varieties of red raspberries indicate that the varieties Cuthbert, King, Marlboro, Latham, Antwerp, and Lloyd George are completely or almost completely self- and cross-fertile. The larger the amount of pollen applied the more certain was the set of seeds obtained.

- 198 Red Raspberry Pollination Technique. Hardy, Max B. Proc. Amer. Soc. Hort. Sci. 28:122-124. March, 1932.

The emasculation of raspberry blossoms was accomplished by cutting around the stem of the flower bud with a sharp scalpel while holding the inverted bud between the thumb and forefinger. The cut is made about one-half way between the stem and largest circumference of the bud. There was a minimum of injury to the pistils and a normal development of the flowers.

- 199 Effects of Stable Manure and Certain Fertilizers on the Microbiological Activities in Virgin Peat. Vandecaveye, S. C. Soil Sci. 33:297-299. April, 1932.

Microbial activities were measured by determinations of CO_2 , NO_3 , NH_3 , and by numbers of specific groups of microbes at regular intervals. The addition of stable manure and treated straw to peat resulted in a greatly stimulated microbial activity. The beneficial effect was derived from the readily available carbon and nitrogen compounds in the manure and straw and not from microflora in the manure or from the addition of superphosphate or sodium nitrate. The addition of lime to the peat greatly stimulated CO_2 production, but caused no increase in numbers of microbes.

- 204 Pollination of Certain Apple Bud Sports in North Central Washington. Overholser, E. L., and Overley, F. L. Proc. Amer. Soc. Hort. Sci. 1931. 28:74-77. March, 1932.

The results of pollination studies of the bud sports of the Delicious, Rome Beauty and Jonathan apples indicate that the bud sports are as efficient pollinizers for other varieties as the parent, and that they also show responses very similar to the parent variety in self-pollination.

- 205 Some Factors Influencing Spray Injury of Apples. Overley, F. L., Overholser, E. L., and Spuler, Anthony. Proc. Wash. State Hort. Assoc. 27:23-30. December, 1931.

Mineral oil injures fruit and leaves if applied in first or second cover sprays, when lime sulfur has been used either in delayed dormant, pink, and calyx sprays. Three or more applications of heavier oils, 85 to 100 seconds viscosity, may reduce the size of fruit and fruit bud formation of heavily loaded trees. Factors favoring oil injury are: (1) heavy fruit load; (2) inadequate water and plant food; (3) weak trees; (4) air temperatures above 90° F. at time of application; and (5) high relative humidity. Stomatal behavior was not appreciably affected by oil and lead arsenate in comparison with the latter alone.

- 206 The Relation of Leaf Area per Peach to Physical Properties and Chemical Composition. Overholser, E. L., and Claypool, L. L. Proc. Amer. Soc. Hort. Sci. 1931. 28:15-17. March, 1932.

Size of individual peaches increased with a greater number of leaves per specimen from 25 leaves up to about 80 to 85 leaves per peach. On unringed branches with 105 leaves per fruit, the size of fruit was reduced, when compared with 85 leaves per fruit. With greater number of leaves per peach on unringed branches the average area in square centimeters per leaf was reduced. With increasing number of leaves per fruit the nitrogen and moisture tended to decrease and total sugars and sucrose percentages to increase in the fruits.

- 207 The Relation of Fertilizers to Respiration and Certain Physical Properties of Strawberries. Overholser, E. L., and Claypool, L. L. Proc. Amer. Soc. Hort. Sci. 1931, 28:220-224. March, 1932.
Nitrogenous fertilizers increased the respiration intensity of strawberries. Phosphorus either alone or combined with nitrogen depressed it. The higher the respiration, the higher the respiration ratio, but the value averaged below unity. Firmness of berries was decreased by applications of nitrogen. Berries from the extra nitrogen plots having the highest respiration intensity had the lowest specific electrical resistance. Berries from the phosphorus plots averaging lowest in respiration averaged highest in specific resistance.
- 208 Sweet Cherry Pollination in Washington for 1931. Claypool, L. L., Overley, F. L., and Overholser, E. L. Proc. Amer. Soc. Hort. Sci. 1931, 28:67-70. March, 1932.
The pollinizers giving the best fruit set with the Bing were Deacon Black Tartarian, Black Republican, Norma, and Montmorency. The best pollinizers for the Lambert were Black Tartarian, Deacon, Montmorency, and Black Republican. The best for Napoleon were Deacon, Montmorency, Norma, Black Tartarian, Black Republican and Parkhill Seedling. The King Albert was incompatible with Bing, Lambert, and Napoleon. The May Duke was a fairly satisfactory pollinizer for both Lambert and Napoleon.
- 209 Some Effects of Irrigation upon Yield and Quality of Potatoes Produced in the Yakima Valley. Claypool, L. L., and Morris, O. M. Proc. Amer. Soc. Hort. Sci. 1931, 28:249-252. March 1932.
The data indicate that the grade and yield of potato tubers can be controlled or greatly modified by the irrigation practices.
- 210 Some Responses of Potato Plants to Spacing and Thinning. Claypool, L. L., and Morris, O. M. Proc. Amer. Soc. Hort. Sci. 1931, 28:253-256. March, 1932.
The data indicate that it is possible to regulate the size and quality of potato tubers within limits by spacing of hills, by the number of plants to the hill, or a combination of the two methods.
- 211 The Relation of Soil Moisture and Spray Applications to Stomatal Behavior and Growth of Jonathan Apples. Overley, F. L., Overholser, E. L., and Haut, I. A. Proc. Amer. Soc. Hort. Sci. 1931, 28:543-546. March, 1932.
With high temperatures and low humidity an earlier closing of stomata may result, even though the soil moisture is above the wilting point while no stomatal response differences were shown by variations in amounts of soil moisture between wilting point and field capacity.
- 212 Some Effects of Fertilizer upon Storage Response of Jonathan Apples. Overley, F. L., and Overholser, E. L. Proc. Amer. Soc. Hort. Sci. 1931, 28:572-577. March, 1932.
The fertilizer application may affect the size, degree and per cent of red color and the time of maturity. Hence, to this extent the firmness of the fruit of representative samples from the different fertilizer plots may be affected.
- 214 Factors Influencing the Cost of Codling Moth Control. Spuler, Anthony; Dorman, Russell, and Gillies, Kenneth Proc. Wash. State Hort. Assoc. 27:31-45. December, 1931.
Favorable climatic conditions for codling moth activity persisted in 1931. Efficiency in lead arsenate increases rapidly up to three pounds per 100 gallons, after which point the dosage becomes less effective for any additional material. Deposit studies show that the fish oil-lead arsenate combination increases the lead arsenate deposit on the fruits. Control studies in the insectary indicate best results with fish oil-lead arsenate second with mineral oil-lead arsenate, third with spreader-lead arsenate and fourth, lead arsenate alone.

- 215 Red Spider Control. Webster, R. L. Proc. Wash. State Hort. Assoc. 27:17-21. December, 1931.
The effect of dormant sprays, mildew sprays of dilute lime sulfur, and summer oils on brown mite, common red spider, European red mite, rust mite, and blister mite, is discussed.
- 219 A 1931 Survey of Little Leaf or Chlorosis of Fruit Trees in Central Washington. Overholser, E. L., Claypool, L. L., and Overley, F. L. Proc. Wash. State Hort. Assoc. 27:6-9. December, 1931.
Apples, pears, and cherries are affected by little leaf in Washington. While a good alfalfa cover crop within a three year period seems to overcome this trouble, in some orchards, because the alfalfa cover crop as a result of severe disking, excessive shading by the trees, or inadequate moisture, is being replaced by weeds, little leaf is reappearing. Control measures are given. The control of chlorosis also is discussed.
- 220 A Progress Report of Studies on Fruit Tree Irrigation, (a) Soil Moisture Studies. Larson, C. A. Proc. Wash. State Hort. Assoc. 27:125-130. December, 1931
The most economical use of water for the type of soil at the Irrigation Branch Experiment Station at Prosser would be 40 inches for the season distributed by applying the proper proportion of water at 15-day intervals. Less runoff occurs, water accumulates in the root zone through the season, and no leaching beyond the root zone takes place. Heavy irrigations for 36 hours every 30 days increased leaching and the loss of water by surface runoff.
- (b) Tree and Fruit Responses. Claypool, L. L. Proc. Wash. State Hort. Assoc. 27:131-135. December, 1931.
In the data presented 30 inches of water were insufficient for the production of good yields of high quality fruit even on orchards which are only 10 years old. Forty acre inches of water seemed to produce nearly as good results as 60 acre inches on the ten year old orchard at the experiment station, notwithstanding the fact that heavy alfalfa cover crop is maintained continuously.
- 224 A Method of Determining the Biological Value of Protein in the Study of Avian Nutrition. St. John, J. L., Johnson, Otto, Carver, J. S., and Moore, S. A. Jour. Nutr. 5:267. May, 1932.
Using the method for mammals developed by Mitchell and the method for the determination of uric acid developed by St. John and Johnson, a method suitable for the measurement of the biological value of protein fed to chicks and birds has been developed.
- 229 The Laundry and Its Problems. Roberts, E. H. Household Management and Kitchens, Publication of the President's Conference on Home Building and Home Ownership. pp. 210-222. February, 1932.
Comparative costs are given for laundering at home and at a commercial laundry. Built-in and movable equipment for the home are discussed. costs being included. Recommendations as to equipment are made for the various income levels.

FINANCIAL STATEMENT
WASHINGTON AGRICULTURAL EXPERIMENT STATION

in account with
the United States Appropriations, 1931-32

Dr.	Hatch	Adams	Purnell
Receipts from the Treasurer of the United States, as per appropri- ations for the fiscal year ended June 30, 1932 under Acts of Con- gress approved March 2, 1887 (Hatch Fund), March 16, 1906 (Adams Fund), and February 24, 1925 (Purnell Fund)			
	\$15,000.00	\$15,000.00	\$60,000.00
 Cr.			
By salaries	1 \$11,518.66	\$12,860.35	\$42,090.70
Labor	2 1,295.71	1,471.24	8,198.48
Stationery and office supplies	3 8.88	70.86	149.25
Scientific supplies, consumable	4 116.32	196.18	1,137.86
Feeding stuffs	5 ———	———	76.78
Sundry supplies	6 122.11	19.34	1,136.21
Fertilizers	7 23.50	8.85	23.04
Communication service	8 .60	9.13	28.93
Travel	9 455.69	286.00	2,440.14
Transportation of things	10 ———	———	76.57
Publications	11 1,077.10	———	1,027.95
Heat, light, water and power	12 ———	———	21.45
Furniture, furnishings, fixtures ..	13 13.70	———	779.83
Library	14 5.00	———	74.45
Scientific equipment	15 318.84	78.05	854.19
Livestock	16 ———	———	213.55
Tools, machinery and appliances ..	17 18.89	———	1,612.24
Buildings and lands	18 25.00	———	58.38
Contingent expenses	19 ———	———	———
Balance	20 ———	———	———
 Total	 \$15,000.00	 \$15,000.00	 \$60,000.00

FINANCIAL STATEMENT
STATE FUNDS EXPENDED ON THE MAIN STATION AND
ALL BRANCH STATIONS

(Excepting Western Washington Station which is operated
Independently)

July 1, 1931 to June 30, 1932

Dr.	State Appropriations	Sales	Totals
Balance, June 30, 1931	\$ ———	\$ 588 10	\$ 588.10
Receipts from other sources than the U. S. for the year ended June 30, 1932	40,169 72	19,093 26	59,262.98
Totals	\$40,169.72	\$19,681 36	\$59,851 08
 Cr.			
Salaries	\$19,562 12	\$ 2,216 63	\$21,778 75
Labor	10,646.25	5,822.72	16,468.97
Stationery and office supplies	282.12	203 45	485.57
Scientific supplies, consumable	818 76	518.25	1,337 01
Feed	1,576.17	2,378.82	3,954.99
Sundry expenses	1,018.15	2,672 52	3,690.47
Fertilizers	93.47	101 10	194 57
Communication service	122 91	149 87	272.78
Travel	1,835 30	765.73	2,601.03
Transportation of things	268.52	171 99	440 51
Publications	———	18 79	18 79
Heat, light and power	250.50	1,280 67	1,531.17
Furniture and fixtures	119 24	62.37	181 61
Library	1,177.85	334.76	1,512.61
Scientific equipment	225.23	47.97	273 20
Livestock	1,465 73	948 08	2,413 81
Tools, machinery and appliances	621.11	662.68	1,283.79
Buildings and land	79.06	1,174 36	1,253.42
Contingent expense	7 23	150.60	157 83
Balance June 30, 1932	———	———	———
Total	\$40,169 72	\$19,681.36	\$59,851 08

FINANCIAL STATEMENT
WESTERN WASHINGTON EXPERIMENT STATION

July 1, 1931 to June 30, 1932

Dr.	State Appropriations	Sales	Totals
Balance June 30, 1931	\$ ———	\$ 4,014.69	\$ 4,014.69
Receipts from other sources than the U. S. for the year ended June 30, 1932	\$36,126.23	22,032.13	58,158.36
Totals	\$36,126.23	\$26,046.82	\$62,173.05
Cr.			
Salaries	\$12,499.80	\$12,399.81	\$24,899.61
Labor	9,957.83	10,528.20	20,486.03
Stationery and office supplies	———	115.98	115.98
Scientific supplies, consumable	460.50	6.39	466.89
Feed	2,986.44	2,070.99	5,057.43
Sundry expenses	1,528.05	227.03	1,755.08
Fertilizers	223.78	———	223.78
Communication service	605.51	80.60	686.11
Travel	1,303.04	191.42	1,494.46
Transportation of things	85.27	14.73	100.60
Publications	———	———	———
Heat, light and power	1,290.59	98.95	1,389.54
Furniture and fixtures	328.53	9.60	338.13
Library	156.22	95.40	251.62
Scientific equipment	1,383.34	17.57	1,400.91
Livestock	368.88	———	368.88
Buildings and land	2,947.85	190.15	3,138.00
Tools, machinery and appliances	———	———	———
Balance, June 30, 1932	———	———	———
Totals	\$36,126.23	\$26,046.82	\$62,173.05

